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# Common Intent:
# A Review of the Literature

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# Common Intent:
# A Review of the Literature

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# Abstract

This report reviews research literature pertaining to the theory of Common Intent (Pigeau & McCann, 2000) and Command and Control (C2). In particular, the review related scientific and military literature to the theory of Common Intent, identified studies that clarify the concept of Common Intent and its role in C2, identified relevant factors and methodologies, and generated recommendations for a research program to explore Common Intent. Based on the review, the report identifies overlapping use of the terms common intent and command intent and makes suggestions to clarify these overlaps. The review also revealed several lines of research related to the theory of Common Intent, including a theory of *Command Concepts*, the concept of mental models, tacit knowledge, and common ground. A framework for research is proposed to examine how common intent affects the generation, communication, interpretation and implementation of command intent in particular mission settings, with different levels of diversity among team members.

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# Résumé analytique

Dans le présent rapport, les auteurs passent en revue des comptes rendus de recherche sur la théorie de l'intention commune (Pigeau et McCann, 2000) ainsi que sur le commandement et le contrôle (CC). Ils établissent notamment des liens entre la théorie de l'intention commune et la documentation scientifique et militaire. Ils mentionnent un certain nombre d'études qui précisent le concept d'intention commune et le rôle que celle-ci joue sur le plan du CC. Ils signalent aussi les méthodologies et les facteurs pertinents, avant de formuler des recommandations sur la création d'un programme de recherche sur l'intention commune. S'appuyant sur ces constatations, les auteurs font ressortir les domaines où les expressions *intention commune* et *intention du commandement* font double emploi, et suggèrent des façons de clarifier ces deux notions. Ils indiquent également plusieurs secteurs de recherche sur la théorie de l'intention commune, y compris la théorie des *concepts de commandement*, le concept des modèles mentaux, les connaissances implicites et les terrains d'entente. Ils proposent enfin un cadre de recherche pour examiner la manière dont l'intention commune influe sur la génération, la communication, l'interprétation et la réalisation de l'intention du commandement dans tel ou tel contexte de mission, lorsque l'équipe est diversifiée.

# Résumé

Dans le présent rapport, les auteurs passent en revue les résultats d'une recherche, par mots clés, de comptes rendus de recherche sur la théorie de l'intention commune (Pigeau et McCann, 1995) ainsi que sur le commandement et le contrôle (CC). Cette théorie vise à apporter des éclaircissements sur la différence entre les facteurs humains du commandement et les aspects techniques du contrôle. Les objectifs poursuivis par les auteurs sont les suivants :

- Établir des liens entre la théorie de l'intention commune et la documentation scientifique et militaire.
- Mentionner un certain nombre d'études concernant le concept d'intention commune et le rôle que celle-ci joue sur le plan du CC.
- Signaler les facteurs susceptibles d'influer sur l'intention commune et, par ricochet, sur le CC.
- Trouver des méthodes pour étudier l'intention commune.
- Formuler des recommandations au sujet d'un éventuel programme de recherche sur l'intention commune.

La recherche par mots clés a fourni 300 titres et résumés, et 70 articles ont été étudiés en détail. Ces articles font état de recherches dans des domaines aussi divers que les communications, les travaux d'équipes de gestion opérationnelle et d'équipes pluridisciplinaires chargées du développement de produits, le CC et l'instruction militaires.

Le rapport renferme des sections consacrées au recensement d'études sur :

- les concepts de l'intention, y compris l'utilisation militaire de l'expression *intention du commandement* et l'idée théorique de l'intention commune;
- le contenu et la structure des pyramides d'intention;
- les concepts liés à l'intention commune;
- la saisie de l'intention commune;
- les facteurs qui touchent la communication de l'intention commune;
- les façons d'améliorer l'efficacité de l'intention commune sur le plan du CC;
- les mesures et les méthodes applicables à l'intention commune;
- le programme de recherche proposé.

S'appuyant sur ces constatations, les auteurs font ressortir les domaines où les expressions *intention commune* et *intention du commandement* font double emploi et suggèrent des façons de clarifier ces deux notions. Ils indiquent également plusieurs secteurs de recherche sur la théorie de l'intention commune, à savoir :

- une théorie sur les *concepts de commandement*, où est analysée l'intention explicite du commandement, telle qu'elle s'applique aux organisations militaires;
- les concepts de *modèles mentaux* liés au rendement d'une équipe;
- les *connaissances implicites* : les connaissances pratiques qui s'acquièrent grâce à l'expérience;

- les *terrains d'entente* : un compte rendu des représentations et des processus des connaissances sur lesquels on s'appuie pour comprendre les communications humaines.

En outre, les auteurs cernent d'éventuelles zones d'application dans le contexte des préparatifs de missions à long, à moyen et à court terme. Ils relèvent, entre autres, les aspects relatifs aux modèles mentaux partagés, aux méthodes des équipes et aux communications. Les activités pratiques susceptibles d'être adaptées au contexte militaire ont été groupées selon les domaines : culture organisationnelle, processus de groupe, instruction, outils de soutien possibles et procédures liées à la génération et à l'utilisation de l'intention de commandement.

Enfin, les auteurs proposent un cadre de recherche pour examiner la façon dont l'intention commune influe sur la génération, la communication, l'interprétation et la communication de l'intention de commandement par les équipes de commandement dans tel ou tel contexte de mission, lorsque l'équipe est diversifiée.

# Table of Contents

**ABSTRACT** ..... III

**EXECUTIVE SUMMARY** ..... V

**TABLE OF CONTENTS** ..... VII

**1. INTRODUCTION** ..... 1

- 1.1 BACKGROUND ..... 1
- 1.2 PURPOSE ..... 1
- 1.3 SCOPE ..... 1
- 1.4 WORK ITEMS ..... 2
- 1.5 DELIVERABLES ..... 2
- 1.6 ACRONYMS ..... 2

**2. METHOD** ..... 3

- 2.1 KEYWORDS ..... 3
- 2.2 DATABASES ..... 5
- 2.3 THE SEARCH ..... 6
- 2.4 SELECTION OF ARTICLES ..... 6
- 2.5 REVIEW OF ARTICLES ..... 6
- 2.6 COMMAND SETTINGS ..... 7

**3. RESULTS** ..... 11

- 3.1 DOMAINS OF RESEARCH ..... 11
- 3.2 SECONDARY REFERENCES ..... 11
- 3.3 STRUCTURE OF THE REPORT ..... 12

**4. THE CONCEPT OF INTENT** ..... 13

- 4.1 INTENT IN MILITARY PRACTICE ..... 13
- 4.2 INTENT AS A THEORETICAL CONCEPT ..... 19
  - ***4.2.1 Sharing Intent*** ..... *21*
  - ***4.2.2 Common Intent*** ..... *22*
- 4.3 THEORY VERSUS PRACTICE ..... 23
  - ***4.3.1 Intent hierarchy*** ..... *24*
  - ***4.3.2 Explicit or implicit*** ..... *25*
  - ***4.3.3 Scope*** ..... *25*
  - ***4.3.4 Format and Responsibility*** ..... *25*
  - ***4.3.5 Intent: Purpose and/or Means*** *25*
  - ***4.3.6 Implicit: status or process*** *27*
- 4.4 RESEARCH IMPLICATIONS ..... 27

**5. INTENT PYRAMID: CONTENT AND STRUCTURE** ..... 31

- 5.1 COMMAND CONCEPTS ..... 31
- 5.2 MENTAL MODELS ..... 33
- 5.3 TACIT KNOWLEDGE ..... 35
- 5.4 EMBEDDED AND EMBODIED KNOWLEDGE ..... 38
- 5.5 RESEARCH IMPLICATIONS ..... 40

**6. COMMON INTENT: RELATED CONCEPTS** 41
6.1 THEORY OF COMMAND CONCEPTS 41
6.2 SHARED MENTAL MODELS 43
6.3 SHARING TACIT KNOWLEDGE 49
6.4 COMMON GROUND 50
6.5 RESEARCH IMPLICATIONS 52
**7. ACQUIRING COMMON INTENT** 55
7.1 TACIT COORDINATION 55
7.2 SOCIALIZATION 58
7.3 DIALOGUE 61
7.4 EXTERNALIZATION 64
7.5 INTERNALIZATION 65
7.6 RESEARCH IMPLICATIONS 66
**8. FACTORS AFFECTING SHARING OF INTENT** 69
8.1 SUPPORT FOR COMMUNICATION 69
***8.1.1 Communication Medium*** *69*
***8.1.2 Common Ground*** *70*
***8.1.3 Organizational Structure and Policies*** *71*
8.2 TEAMWORK AND TEAM MENTAL MODELS 73
8.3 TRAINING 76
8.4 ORGANIZATIONAL STRUCTURE AND DIVERSITY 80
***8.4.1 Organizational Philosophy*** *81*
***8.4.2 Group Diversity*** *82*
8.5 RESEARCH IMPLICATIONS 86
**9. ENHANCING SHARED INTENT** 87
9.1 FRAMEWORK FOR ENHANCING COMMON INTENT 87
***9.1.1 Enhancing the Sharing of Intent*** *87*
***9.1.2 Enhancing the Transformation of Shared Intent into Effective Performance*** *89*
**10. MEASURES AND METHODS** 97
10.1 APPROACHES 97
***10.1.1 Experimental Research*** *97*
***10.1.2 Field Observation*** *98*
***10.1.3 Surveys*** *99*
***10.1.4 Task Analysis*** *99*
***10.1.5 Simulation*** *100*
10.2 SPECIFIC METHODS 100
10.3 CRITERIA, MEASURES AND METHODS 104
***10.3.1 Quality of Command Intent*** *105*
***10.3.2 Measures*** *106*
***10.3.3 Methods*** *106*
10.4 SHARED MENTAL MODELS 107
***10.4.1 Measures*** *107*
***10.4.2 Methods*** *107*
10.5 GROUP PROCESSES 108
***10.5.1 Measures*** *110*
***10.5.2 Methods*** *110*
10.6 DECISION MAKING 111
***10.6.1 Measures*** *112*
***10.6.2 Methods*** *112*

10.7 COMMUNICATION ... 113
*10.7.1* ***Measures*** ... *113*
*10.7.2* ***Methods*** ... *114*

**11. DISCUSSION AND PROPOSED RESEARCH PROGRAM ... 115**

11.1 FEATURES OF A RESEARCH PROGRAM ... 117
*11.1.1* ***Primary thrusts:*** ... *117*
*11.1.2* ***Issues of context*** ... *118*
*11.1.3* ***Methodological Issues*** ... *120*
*11.1.4* ***Future Steps*** ... *121*
11.2 PROPOSED RESEARCH APPROACH ... 122
11.3 EXPRESS RESEARCH QUESTIONS ... 126
*11.3.1* ***Research Paradigm*** ... *127*
*11.3.2* ***Research Goals and Questions*** ... *132*
11.4 SUMMARY ... 136

**12. REFERENCES ... 139**

**13. GLOSSARY ... 147**

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# 1. Introduction

## 1.1 Background

In recent years, Pigeau and McCann re-conceptualized Command and Control (C2) in terms of explicit, implicit, and common intent to distinguish more human-centred Command issues from an increasingly dominant focus on technology-centred Control issues. Specifically, they defined C2 as "*the establishment of common intent and the transformation of common intent into coordinated action*" (Pigeau & McCann, 2000). Their concept puts the emphasis on the human in command and issues of command (as opposed to control) such as cognition, leadership, motivation, and organizational structure.

If a key to effective command is the formulation, communication, and implementation of common *intent*, what is intent? To begin to answer this question, Pigeau and McCann (1995, 2000) have proposed a framework for discussing intent in the context of military C2. Recently, they have sought to promote empirical research and development of a theory of C2 based on the concept of shared intent. This review is a first step toward developing a research program to refine the concept of intent and develop a theory of how intent is shared and what role it plays in mediating C2 and task performance in the military context.

## 1.2 Purpose

The purpose of the literature review was to develop ideas related to the empirical investigation of intent. The literature review was intended to:

- Relate the scientific and military literature to Pigeau and McCann's conceptual analysis of intent.
- Identify theories and empirical results that clarify the concept of intent and its role in C2.
- Identify factors that could affect intent and its impact on C2
- Identify methodologies for the study of intent.
- Generate recommendations for a research program to explore common intent.

## 1.3 Scope

The literature review concentrated on intent as it applies to military C2 but drew upon research examining analogous team concepts or circumstances in other domains such as product design, marketing, and strategic business decision making. A broad perspective within the military C2 area was adopted, addressing issues across services, ranks, and operational areas. The review covered literature from North American, European, and Australian research and development. The term "command" was not restricted to senior positions in large military formations but was intended to cover all sizes of military unit down to infantry section. Within large multi-function units, the focus was as much on the command team as the individual commander.

## 1.4 Work Items

The following work items were undertaken:

1. A search of the literature to identify relevant journal articles, reports, books, etc. pertaining to the concept of and factors affecting common intent
2. References to relevant literature were recorded in an EndNote database.
3. Approximately 60 articles were selected from those identified in the search and reviewed.
4. A report documenting the results of the literature review was written.

## 1.5 Deliverables

The following deliverables were made under this contract.

1. An EndNote bibliography of pertinent titles on common intent and related topics, including all articles identified as of interest, and including the notes made in the review
2. Paper copies of the articles reviewed (or microfiche where paper copies were not available).
3. A report on the literature review.

## 1.6 Acronyms

| | |
|---|---|
| ACE | Aircrew Coordination Evaluation |
| ASWC | Assistant Sensor Weapon Controller |
| ATM | Aircrew Training Manual |
| C2 | Command and Control |
| CF | Canadian Forces |
| CIC | Command Information Center |
| CISTI | Canada Institute for Scientific and Technical Information |
| CIVMARS | Civilian Mariners |
| CM | Conceptual Mapping |
| CMAQ | Cockpit Management Attitude Questionnaire |
| CO | Commanding Officer |
| CT | Command Team |
| CTA | Cognitive Task Analysis |
| DND | Department of National Defence |
| IFM | Information Flow Method |
| MDS | Multi-Dimensional Scaling |
| MSC | Military Sealift Command |
| NASA | National Aeronautical Science Administration |
| NATO | North Atlantic Treaty Organization |
| NPD | New Product Development |
| NTIS | National Technical Information Service |
| OOTW | Operation Other Than War |
| OPORD | Operation Order |
| Ops O | Operations Order |
| ORO | Operations Room Officer |
| RMC | Royal Military College (of Canada) |
| ROE | Rules of Engagement |
| RPI | Rich Personal Interaction |
| SA | Situation Awareness |
| SAGAT | Situation Awareness Global Assessment Technique |
| SME | Subject Matter Expert |
| SOP | Standard Operating Procedure |
| SWC | Sensor Weapon Controller |
| TACT | Team Adaptation and Coordination Training |
| TAO | Tactical Action Officer |
| TARGETS | Targeted Acceptable Responses to Generated Events or Tasks |
| TASQ | Thomas and Anderson Socialization Questionnaire |
| TG | Task Group |
| TK | Tacit Knowledge |
| TKS | Tacit Knowledge Survey |
| TMT | Top Management Team |
| TPAB | Team Performance Assessment Battery |
| UK | United Kingdom |
| U.S. | United States of America |
| WWW | World Wide Web |

# 2. Method

## 2.1 Keywords

We developed a set of keywords for the literature search based on our experience with the pertinent technical literature on psychological and social factors in analogous domains and with goals, functions, processes, tasks, and interfaces relevant to military command and control.

The keywords were divided into several categories (see Table 2.1). This division allowed pairing of non-overlapping keywords for the search. Keywords could be combined in any way that yielded a productive number of references (i.e., not too large a number to inspect or too few to provide reasonable coverage of the topic). The "*core concept*" category was included for two reasons. First, the keywords in that category focused the search on topics directly related to common intent. Second, they were intended to identify any other related theoretical approaches or conceptualizations that might have been developed.

| Category | Keyword | Related Keywords |
|---|---|---|
| **Core concept** | Intent | Intention, goal, objective, battle plan, command hierarchy/structure |
| **Cognitive Factors** | Cognition | Knowledge, attitude, attention, information availability, stress, attitude change, common ground, psycholinguistics, comprehension, learning, distance learning, mental model, group situation awareness, conceptual thinking |
| **Organizational Factors** | Organization | Lines of communication, command hierarchy/ structure, cohesion, team stability, experience with organizational levels, role conflict, group-shared values, socialization, institutionalization, whistle-blowing(er), authority, conformity, group/team effectiveness, group/team decision making, group homogeneity, organizational structure, group structure, team role |
| **Individual differences** | Individual differences | Leadership, verbal fluency (written and spoken), experience, gender, initiative, cultural background, motivation, individuality, need for achievement, tolerance of ambiguity |
| **Communication Factors** | Communication | Medium, frequency, timeliness, cognitive aptitudes, bilingual communication, non-verbal communication ("body language"), technology, tacit knowledge, lines of communication, communication mode, conferencing, transaction |
| **Societal Factors** | Society | Religion, ethnic background, education, cultural expectations, stability of culture, cultural norms, social interaction |
| **Military Domain** | Military | Service (army, navy, air), arm (infantry, SWC, ASWC, etc ), rank, strategic goals, tactical goals, Rules of Engagement (ROEs), training, basic training |

**Table 2.1. Keywords**

To aid in the identification of relevant articles, we also categorized keywords in terms of the propositions advanced by Pigeau and McCann (2000), with the exception of those related to leadership, which was deemed to be outside the scope of the search and review (see Table 2.2). These propositions offer general research issues related to the conceptualization of the intent hierarchy, sharing intent, and organizational structure. These were major areas of inquiry in the literature review.

| Proposition | Related Keywords |
|---|---|
| **Intent Hierarchy** | |
| 1 Conflicts between layers in the intent hierarchy can be resolved by<br>- modifying one or both conflicting values<br>- tolerating the inconsistency | Tacit knowledge, role conflict, group-shared values, socialization, institutionalization, attitude change, lines of communication, command hierarchy/structure, cohesion |
| 2 Modifying lower level expectations will be more "difficult" than higher level expectations. | As above |
| 3 Tolerating inconsistent expectations (or values) will be stressful The amount of stress will be directly proportional to the severity of the inconsistency | Whistle-blowing(er), authority, attitude change, socialization, conformity, basic training ("boot camp"), cultural norms, tolerance of ambiguity |
| **Sharing Intent** | |
| 4. Sharing explicit intent (dialogue and externalization) will be facilitated by wide bandwidth communications using a stable language and protocol. | Common ground, psycholinguistics, comprehension, communication mode, social interaction, distance learning, conferencing, communication technology, tacit knowledge, bilingual communication, frequency, medium, timeliness |
| 5 Sharing implicit intent (socialization and internalization) will be facilitated by:<br>- frequent opportunities for verbal and non-verbal interaction<br>- a rich base of experiences on which to draw | As above |
| **Common Intent** | |
| 6 To compensate for relative lack of shared implicit intent, joint and combined operations will require greater amounts of shared explicit intent (for operations of comparable size) to achieve a given level of common intent | Mental models, group situation awareness, group/team effectiveness, group/team decision making, group homogeneity, tacit knowledge, experience, conceptual thinking, societal factors |
| **Organizational Structure** | |
| 7. Centralized C2 organizations promote explicit intent instead of implicit intent to achieve a given level of common intent. De-centralized organizations promote implicit intent instead of explicit intent. | Organizational structure, group structure, team roles, communication, transactions, role conflict, lines of communication, command hierarchy/structure |

**Table 2.2: Keywords Categorized by Intent Proposition**

In addition to the set of keywords, we also identified a number of topics that could be relevant (see Table 2.3). These topics served as further search terms:

- Attribution model (leader behavior)
- Common ground( communication)
- Contextual factors in leadership
- Effective work teams
- Followers/followership
- Group cohesiveness
- Group cohorts
- Group conformity
- Group demography
- Group development
- Group member roles
- Group norms
- Group shared values
- Groupthink
- Implicit understanding
- Leader-member exchange model
- Leadership competencies
- Legitimate power
- Organizational culture
- Organizational learning
- Path-goal theory (of leadership)
- Psychological contract
- Referent power
- Reward power
- Role conflict
- Social facilitation effect
- Social learning
- Social loafing
- Tacit knowledge

**Table 2.3: Search Topics**

We identified several journals likely to contain relevant articles. In addition to searching on the basis of topic keywords, we also examined the contents of the journals below.

- Communication Research.
- Group and Organization Management.
- Journal of Applied Psychology.
- Journal of Organizational Behavior.
- Journal of Personality and Social Psychology.
- Leadership Quarterly.
- Organizational Behavior and Human Decision Processes.
- Organizational Dynamics.
- Perceptual and Motor Skills.
- Personality and Social Psychology Bulletin.
- Personnel Psychology.
- U.S. Army Research Institute for Behavioral and Social Science Reports

## 2.2 Databases

Searches were conducted of the following databases and sources:

- PsycInfo.
- National Technical Information Service (NTIS).
- Canada Institute for Scientific and Technical Information (CISTI).
- ABI/Inform.
- World Wide Web (WWW).

PsycInfo is a department of the American Psychological Association (APA) that offers products to aid researchers locate psychological literature. Their database is based on Psychological Abstracts and contains non-evaluative summaries of literature in psychology and related fields (e.g , human factors, education, business, and social studies). The database contains over one million electronically stored bibliographic references with authors, titles, publication information, and abstracts or content summaries, covering material published in over 45 countries since 1967. References include journal articles, dissertations, reports, and book chapters.

NTIS is an agency of the U.S. Department of Commerce's Technology Administration. It is the official source for government sponsored U.S. and worldwide scientific, technical, engineering, and business related information. The database contains almost three million titles, including 370,000 technical reports from U.S. government research The information in the database is gathered from U.S. government agencies and government agencies of countries around the world.

CISTI houses a comprehensive collection of publications in science, technology, and medicine. It contains over 50,000 serial titles and 600,000 books, reports, and conference proceedings from around the world.

ABI/Inform is a business and economics database that indexes and abstracts the business periodical literature from 1971 to the present.

## 2.3 The Search

We searched databases by applying keywords from different categories in combination. For example, we combined a keyword from the Core Concept category with one from the Cognitive Factors category The results of this pairing were used to determine whether the combination needed to be refined to be more or less inclusive. When a combination yielded too many references, we systematically added keywords from the other categories to focus the search. When the combination yielded too few references, we dropped one of the keywords from the combination or replaced one keyword with a related term.

Another source of potentially relevant references was the set of relevant articles obtained for review These articles cited many sources, some of which were clearly related to common intent and C2, even if they addressed issues outside the military domain. The keywords were necessarily restrictive to exclude irrelevant articles. A search for secondary references allowed us to identify some references that might otherwise have been missed. The search for secondary references took advantage of the work done by authors in locating and summarizing pertinent research. We identified articles cited in the reference lists of the articles obtained for the review on the basis of their potential relevance to common intent.

## 2.4 Selection of Articles

The search of the databases generated approximately 300 titles and abstracts. We reviewed these and categorized each by its priority (high, medium, or low) to the purpose and scope of the literature review. Priority was based on the extent to which the article seemed to apply to the main categories of keywords developed earlier (Table 2.1). Once titles and abstracts were prioritized, we identified the approximately 80 articles that were rated as highest priority and obtained as many of these as possible. We were able to obtain 70 articles for review.

## 2.5 Review of Articles

We read each of the 70 articles obtained for review in detail, taking notes. After reviewing approximately 30 articles, we developed a broad outline of the major issues. We used this outline to categorize the applicability of articles and to focus further review of the obtained articles.

## 2.6 Command Settings

Military command is generally exercised through small, often multi-disciplinary, command teams within a hierarchical organizational structure, working to achieve a set of inter-related objectives. Thus, a commander at one level will be a subordinate at another. With several commanders at a given level, there may often be the need for lateral as well as vertical coordination. The size, composition, scope and division of responsibilities of each command team may vary. At lower levels within a single specialty, such as an infantry section, one position may fill several roles. Within a battle group or brigade, with more specialties and greater resources, there will be more division of labour with different positions assigned different roles. These roles are performed within a Command Team, often with each member being a "commander" or team leader in their own right for their own specialization

As responsibilities are delegated, the goals of higher levels of command within the overall organization will delimit the goals of lower levels as well as the activities that can be undertaken to achieve the goals. As organizational diversity increases, the clarity of organizational structure and associated goals and responsibilities will diminish. For example, clarity should decrease as one moves from within a single arm such as infantry, to multiple arms, to joint service, to multi-national forces, to Operations Other Than War (OOTW) involving different factions, civil government, and Non-Governmental Organizations such as humanitarian aid services.

Although time scales vary, military operations follow a certain progression. Operations progress from the big picture of long term national interest down to the implementation of a particular mission by a particular sub-unit, as follows:

- Preparing a general military capability based on national strategic requirements, including organizing, equipping and training an appropriate force.
- Planning and preparation for a campaign in a particular theatre; i.e. a series of missions in support of a national objective.
- Planning and preparing for individual missions, with different units in the organization groupe appropriately and assigned different roles and responsibilities according to their specialty.
- After each component in the organization is assigned its responsibilities then, in turn, that component assigns responsibilities to each of its parts with each part requiring the opportunity to plan and prepare.
- Finally a mission is implemented, under more or less unpredictable circumstances.

As a point of reference for this review, and as the source of examples where appropriate, two different Canadian command settings have been held in mind within this general framework: one Navy and one Army.

The Navy setting concerns the Command Team (CT) on a frigate that is, in turn, part of a small Task Group (TG). The CT would comprise the Commanding Officer (CO) in the position of authority working through the Operations Room Officer (ORO), the Sensor Weapons Coordinator (SWC), and the Assistant Sensor Weapons Coordinator (ASWC). Under the overall command of the ship's CO and within the framework provided by the mission objectives and plan as well as the current Rules of Engagement (ROE), the ORO directs the deployment of the ship's sensors and weapons and the tactical maneuvers of the ship. The ORO's direction is implemented through responsibilities assigned to the SWC and ASWC, each of whom is responsible for a specialist team of operators. These and other teams within the OR are coordinated by the ORO, following appropriate practiced procedures, to achieve a successful mission outcome in the light of evolving circumstances of enemy threats, changing resources, environmental conditions, and other factors. The CT must interact with, and take account of, not only sensor and weapon issues but also other ship-related issues, such as mechanical, personnel, electronic, and other capabilities. Above and around such issues are TG-related concerns, such as interaction with other elements in the TG (ships, aircraft, etc.), the division of responsibilities assigned within the TG, and the wishes of the TG commander, as expressed through the TG staff, for the different warfare areas (air, surface, and sub-surface).

The Army setting concerns an infantry Combat Team, which is, in turn, part of a larger Battle Group. The composition of a Combat Team may vary but typically comprises a company-sized infantry unit of three platoons plus a headquarters. Each platoon comprises three sections, each mounted in a separate vehicle and deployed on foot as necessary. This infantry backbone may be supported by a troop of armoured vehicles. The Combat Team will have access to support from other weapon systems such as artillery, or mortars, combat engineer support for dealing with or creating obstacles, and logistic support for re-supply, evacuation of casualties, etc. In conventional warfare, coordination is normally required with similar sized units on either flank. In OOTW, coordination may be required with other organizations outside the military such as local government and disaster relief groups. In either case, coordination may be required with the military of other nations. Rather like the Navy setting, the commander of the infantry Combat Team works through a command team of specialists with responsibility for providing both advice and taking on tasks of their own.

Thus, both settings involve small cross-specialty decision making teams with multiple levels of delegation of command working to pool information, arrive at a common decision and then co-ordinate closely to achieve a common purpose, yet remain able to synchronize adaptive changes based on unforeseen circumstances. This process of cooperative decision making and implementation is usually carried out under time and other stresses while geographically distributed. The decision making group will usually be working within a set of nested mission requirements - that is, the command level of interest works within a framework provided by the higher level of command and itself delegates framed areas of responsibility to lower levels of command. Although the settings described here focus on an intermediate level of command in order to provide complexity and multi functionality, nevertheless the concepts of command vision[1] or intent are meant to apply at all organizational levels of command: from theatre commander to infantry section.

A critical research goal is to understand (for command at any level) how, for a given mission, strategic intent is first developed and then effectively promulgated to each level of command. Once promulgated, there is the question of how implementation can be subsequently adapted and coordinated to maintain the original intent in the face of changing circumstances and incomplete information about how any change may affect other units.

The Army and Navy settings outlined above will be used to provide a context in which to consider the material reviewed in this report and to help explore key concepts related to common intent as well as the relationship of these concepts to analogous processes outside the military. Examples of analogous processes or conditions held in common with other domains (such as marketing, strategic business management, development and communication of entrepreneurial vision and integrated product development teams) include:

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[1] The term "vision" is sometimes used to describe a commander's general concept of an operation, including its objectives, general method, and constraints

- Working to develop and promulgate a common vision or intent to achieve strategic goals.
- Decision making teams working within a framework of higher strategic requirements.
- Sharing knowledge to make decisions within a multi-level multi-function group.
- Groups with diverse and potentially conflicting organizational cultures.
- Varying levels of empowerment and other forms of motivation within the group.
- Group processes used to improve group interaction and decision making.
- An uneven distribution of decision related information among a group
- Geographically distributed decision teams.
- Pooling information using various technological means.

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# 3. Results

We obtained 70 articles for review and these are referenced at the end of the main report. These articles were drawn from published journals and military and government reports. The obtained articles covered a range of research areas, from which we attempted to draw patterns relevant to common intent.

## 3.1 Domains of Research

The articles obtained for review came from a number of research areas:

- Military.
- Business/Marketing/Product Design.
- Behavioral Science/Communication.
- General Team Research.

Quite a few of the articles were drawn from studies of military C2 and related issues, such as teamwork, training, and command theory. We, of course, searched specifically for articles in the military domain but our search was fruitful only because military scientists and researchers have spent a considerable amount of effort looking at C2 and, in some cases, the concept of Common Intent.

It became clear early on, however, that many articles from the business domain addressed issues closely related to military C2. Business organizations, after all, are similar to military organizations in many respects. Thus, researchers have studied leadership, teamwork, and related issues in business organizations. We selected articles from this domain that appeared to provide insight applicable to issues of common intent in the military. More specifically, there exist relevant bodies of research on:

- Top management teams strategic decision making.
- Dynamics of information exchange within marketing and product development teams.
- The development and communication of entrepreneurial vision.
- Mental models, team training, and effective team performance

The articles obtained for review covered the intent, cognition, organizational, and military categories of our original keywords (see Table 2.1). We obtained, however, relatively few articles pertaining to the individual differences and society categories. This presumably reflects the constraint of the scope of our review, which limited us to 70 articles, rather than a lack of research in these areas.

## 3.2 Secondary References

From the 70 primary references we identified a total of 116 secondary references (provided in Annex A). The references comprise journal articles and technical reports from the behavioral sciences, military research, and business management domains.

## 3.3 Structure of the Report

The theory of Common Intent is complex and draws together concepts from different areas of research. Thus, there is no simple division of the literature surveyed such as theoretical and empirical. Often, articles that advance a pertinent account of teamwork also present empirical results that bear on different aspects of the theory. Accordingly we have discussed the evidence in terms of prominent concepts in the theory of Common Intent even though this sometimes results in a repeated reference to one article at different points in the review

In the next section, the use of the term *Intent* in the military literature and the main concepts in Pigeau and McCann's theory of Common Intent are briefly outlined. The following sections describe the other evidence found in the literature search and try to relate this to both the theory of Common Intent and the military context, and to draw practical and research implications. This is done under the following headings:

- Intent Pyramid: Content and Structure.
- Common Intent· Related Concepts.
- Acquiring common intent .

Subsequent sections go on to discuss:

- Factors affecting the sharing of intent.
- Enhancing shared intent.
- Methods and measures for studying intent.

A final section draws together the implications of previous sections to suggest areas of further research

# 4. The Concept of Intent

Traditional definitions of Command and Control (C2) do not always clearly distinguish *Command* from *Control*. Instead, the term *Command and Control* is much more popular and covers both directive authority and the means by which directions are implemented. As a term, the common view of C2 seems to be that of a *process* that emphasizes control and downplays command. This loses sight of human centred issues of authority, cognition, and responsibility to focus instead on procedural, organizational, and technological issues that, of themselves, do little to help commanders make decisions and lead forces. Taking this as a point of departure, Pigeau and McCann (Pigeau & McCann, 1995, 2000) have proposed new definitions of command, control and C2, taken as individual concepts. A key concept that emerges from their analysis is that of intent. Their concept of intent is more broadly based than that of a commander's intent expressed in formal orders. This section starts with some observations on the use of the term *intent* in the military literature and progresses to an outline of the theoretical concept of intent as developed by Pigeau and McCann.

## 4.1 Intent in military practice

It has been recognized for centuries that a military commander's intent, or vision,for a given mission, whether at the level of the infantry section or entire army, is a key to success of that mission.[2] The way in which this intent should be formulated, communicated, and implemented has been a matter of debate among military philosophers, commanders, and nations that have adopted different perspectives on each aspect of the commander's intent. Over the years, popular opinion has swung between centralized control and decentralized initiative, between styles of leadership, command as individual difference or learned skill, the appropriateness of analytical and intuitive decision making, human or technology-centred support systems, and an emphasis on team decision making or the individual genius of a charismatic leader.

Understanding of the formal military use of the concept of intent must be set against a framework of delegated responsibilities for a military mission within a, more or less, hierarchical organizational structure. Within that structure, various technical specialties must be able to co-operate to achieve a common purpose. In the U.S. and Canadian military documents reviewed (*Canada's Army*, 2000; *Civil Military Cooperation in Peace, Emergencies, Crisis and War*, 2000; *Dispatches, Volume 5, No. 1. Manoeuvrist Approach to Ops and Mission Command*, 2000; *The Infantry Section and Platoon in Battle*, 2000; *Land Force, Volume 1, The Conduct of Land Ops*, 2000; *Land Force, Volume 2, Tactical Level Doctrine for the Canadian Army*, 2000; *Land Force, Volume 3, Command*, 2000, *Leadership and Command on the Battlefield - Just Cause/Desert Storm*, 2000; *Operation Joint Endeavor - TF Eagle Initial Impressions Report*, 2000; *Operations*, 2000; *Tactical Decision Making Abbreviated Planning*, 2000; *Warfighting*, 2000; Woodward, 1997), there is repeated reference to a commander's "Intent", "Concept of Operations", or "Vision" whether in terms of doctrine, training, or lessons learned from operations such as Desert Storm. In some nations, terms may differ. For example Rupert Smith (Commander of the UK Armoured Division in Desert Storm) writes "We use the term *directives* when we refer to commander's intent. It's a formal document and it is used as the basis upon which subsequent decisions are expected to be made by your subordinates. ... you must state what it is you wish to achieve rather that what others are to do (*Leadership and Command on the Battlefield - Just Cause/Desert Storm*, 2000)."

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[2] The term vision is often used by military personnel to describe a commander's overall concept of how an operation is to be conducted and how it will unfold. The use of this term can be somewhat loose, covering plans, ideas, and vague understandings of contingencies. Consequently, it is unclear exactly how the concept of vision corresponds to the concept of intent but the two share certain elements.

Despite some minor differences in terminology, the ideas underlying a *commander's intent* as a formal military concept seem to be widely shared; i.e., it relates to ends more than means. Also shared is agreement about the importance and utility of a commander's intent statement for a successful mission outcome, especially where multiple units are involved. The concept of intent is related to several other concepts including:

- Mission Command.
- Decentralizing Authority.
- Unity of Effort.
- Trust and Mutual Understanding

Mission command is a style of command core to the Manoeuvrist approach (*Dispatches, Volume 5, No. 1. Manoeuvrist Approach to Ops and Mission Command*, 2000). Central to this theme is the idea that all activities must centre on and support the commander's expression of the design of the battle through the commanders intent. Shattuck (1996) describes the German philosophy of *Auftragstaktik*, or mission oriented command, as a philosophy of collective creativity in the face of the unforeseeable opportunities provided by battle. This philosophy requires (rather than simply permits) individual commanders at all levels to take the initiative and act in the collective interest to complete the mission as circumstances change. To be able to do this, commanders need more than a directive; they need a lifetime of cultural experience to learn how to act on their own initiative, trust that others will be doing the same, and an understanding that they will be rewarded rather than punished for taking risks. Such a culture is not the work of a moment.

Decentralizing authority is a principle whereby decision-making is set at the lowest possible level and exercised by local commanders on the spot. Such decentralization is intended not only to locate decision making at the point of action during the mission but also to free commanders to think about issues appropriate to the applicable level of command. Often made explicit is the need to formally delegate and bound authority for decision making in relation to sub-components of a mission. Related concepts are those of *Freedom of Action* provided to, and *Initiative* expected of, subordinate commanders, provided subordinates' actions are consistent with the framework of the commander's intent one or two levels up the chain of command.

Unity of effort implies a requirement to provide, through the statement of intent, a common focus for potentially divergent activities of subordinate commanders. The concepts related to decentralization are seen as requiring a balance with the need for synchronization of action between cooperating units, given the risk that synchronization may be lost when subordinate commanders exercise the initiative implicit in decentralization.

Trust and mutual understanding of commanders for subordinates and vice-versa, which are required to ensure that there is the will and capability, as well as the comprehension, to carry out the stated intent within the framework of decentralization. Often made explicit is the need to build trust and mutual understanding within and between units long before the start of a mission. Examples include training based on common doctrine and procedural standards, rehearsals of mission activities, back briefing from subordinate commanders to ensure comprehension. Similarly, there are often allusions to the need to seek out and overcome likely obstacles to trust and common understanding. Examples might include units or individuals recently arrived in theatre (due to augmented peace-time strengths from reserve units, casualties, reinforcements, or hostility only conscripts) or units without a common background (e.g., among different military arms or technical specialties, multi-national forces, and non-government organizations in OOTW). In the case of OOTW, increasing decentralization and delegation of sensitive tasks to small units in volatile uncertain conditions is thought to lead to greater dependence on well understood statements of commanders intent amongst opposing factions as well collaborating military and civil units. This has even led, for example in Bosnia, to the formation of special liaison groups with the express and reciprocal task of communicating intent on behalf of the Force Commander among the various stakeholder groups (including opposing factions).

It seems self evident that military units speaking a different language, using different tactics and procedures, possessing different national goals, using equipment with different capabilities, and coming from radically different cultures, will be less able to communicate and coordinate their activities effectively, especially in the face of volatile circumstances and under stress. Indeed, the concept of NATO is built, in part, on the assumed benefits of commonality, which is why NATO sets standards for member nations. Within armies, the need to synchronize activity based on common understanding of team functions may be explicitly recognized and fostered through common experiences or regimental traditions (Winslow 1998, Gumbert 1996). Although such practices have the intention of fostering cooperative mutually supportive behaviours within a given unit, they may not always give rise to productive behaviours or cooperation between units (Winslow, 1998).

The formal components of a military commander's intent statement most commonly appear to be *purpose*, *method* (or tasks), and *desired end state*, with a strong emphasis on brevity and clarity. Whatever the prescribed format, the intent statement is expected to precede any detailed instructions. There is debate (Shattuck, 1996 ) about the appropriateness of including 'method' at all within a statement of intent. This is on the grounds that a lengthy method section within an intent statement may prove counterproductive to the aim of the intent statement; i.e., to provide a goal related reference point to guide initiative in unforeseen circumstances which may need a break from what was planned. An alternative to including an outline method may be some explicit statement of the constraints on actions or approaches that subordinates may take in the event that the plan fails. The 'concept of operations' is sometimes described as being included in the statement of intent and sometimes vice-versa. Sometimes the terms 'purpose' and 'intent' appear to be used inter-changeably. But these are small differences and the general pattern is unified and clear.

The format and place of the intent statement in written or formal orders appears to vary little with respect to unit level. For example, Canadian infantry platoon and section doctrine states that the superior commander's statement of intent (i.e., for a combat team or battle group) should appear in the friendly forces paragraph of orders (*The Infantry Section and Platoon in Battle*, 2000; *Land Force, Volume 1, The Conduct of Land Ops*, 2000). The immediate commander's statement of intent should appear either as part of the mission statement or as the opening statement in the concept of operations paragraph. The level of detail to which the statement of intent is written tends to be a function of the kind of orders promulgated and the time available.

Occasional reference is made to the idea that, in the final analysis, any statement of intent is related to national interests and objectives, whatever the level of unit in question. A related implication of many military discussions of formats for communicating intent is that statements of intent must be nested in some way for a multi-level military organizational structure. For example, there is the requirement to include as part of the description of the 'Situation' at the start of a typical verbal or written orders sequence, the mission or concept of operations one level up and the commander's intent two levels up Others (e.g., Shattuck 1996) have suggested constructing an integrated hierarchy of intent statements for an operation and providing subordinates with access across several layers. Although, in conventional warfare, it may be hard to imagine an infantry section leader needing to take into account national objectives during local actions, it has been suggested that, in some OOTW, leapfrogging of traditional chains of command may occur as the independent actions of very junior local commanders take on major significance (Dallaire, 2000).

Lessons learned from operations such as Desert Storm or the Falklands War[3] indicate the importance of lateral communication about intent and method among subordinate commanders. However, this only referred to communication during mission training, rehearsal, and implementation rather than as part of the statement of intent itself, where the emphasis appears to be exclusively on vertical rather than lateral linkages of intent.[4]

Formal reliance of commanders on others to pass information about intent is considered important, especially during an operation. In Desert Storm, whatever the size of the unit, this role was termed the 'Battle Captain.' This position, at the level of large units, would be the Chief of Staff or G3 (executive or operations officers at lower levels). One aspect of this role was to know and be able to speak for their commander in matters of intent during preparation and implementation of the mission Another aspect of this role was to provide the commander with a clear picture of the battle in relation to the concept of operations and the continuing validity of the commander's intent in the face of emerging circumstances. This is in addition to the common tasks of such positions to ensure that "..routine things happen routinely." (John Tilelli Jr, Commander U.S. 1st Cavalry Division, Desert Storm) (*Leadership and Command on the Battlefield - Just Cause/Desert Storm*, 2000). "I, as commander, am responsible for both (command and control) but I only do command. It is the function of the chief of staff .... to do my control for me." (Rupert Smith, Commander 1st Armoured Division (UK) Desert Storm) (*Leadership and Command on the Battlefield - Just Cause/Desert Storm*, 2000).[5] Implicit understanding of intent between the person in the Battle Captain role and the Commander was seen by field commanders during Desert Storm as a key to smooth control of everything from the flow of information to the re-supply of ammunition.

Statements about the importance of command post teams and liaison officers made during both planning and implementation of a mission indicate that responsibility for passage and management of intent related information should be delegated (Shattuck, 1996). This responsibility may be delegated to a specialized "gate holder" or even to a special group or team of individuals. Although often neglected as a systematic staffed role during peace time for reasons of lack of personnel resources, liaison has been repeatedly proved indispensable during war. Moreover, the perceived need for liaison increases for OOTW.

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[3] In Desert Storm, the term used was "*Cross Talk*" and in the Falklands War, a radio net for lateral discussions among unit commanders was called "Cackle" (Woodward, 1997)

[4] Observations by the authors of commanders briefings during Canadian command post exercises at the Division, Brigade, Battle Group, and Combat Team is that any such briefing was invariably followed immediately by intense across specialization (e g , armour to artillery) small group discussions These discussions were not only about means, but also about interpretation and sharing of intent Not infrequently these discussions came back with issues to the commander (or the commander's representative) for clarification.

[5] The view that commanders should only receive or send intent related information during the battle to allow them to exercise command in person but to control by delegation is echoed by other authors such Builder et al (1999) based on their analysis of earlier battle histories

Desert Storm can be seen as an example of the success of decentralized execution of centrally prepared plans. This seems to contradict the previous quotes that emphasized the need for decentralized authority, freedom of action, and initiative among subordinate commanders. It makes less clear the role of the intent statement in planning during Desert Storm. Was the concept of freedom of action restricted to *implementation* of largely centrally determined and detailed plans should these plans have failed to allow for emerging circumstances? Or did that freedom extend to the *development* prior to the operation of individual unit plans by subordinate commanders provided these plans dovetailed with higher (and lateral) statements of intent and concepts of operation?

Given the frequently stated need for synchronization of effort among subordinate commanders, the question arises as how that synchronization is achieved: bottom-up, top-down, or laterally. Presumably, there are several possible combinations of this balance with differences appropriate to different circumstances. Contrasts in that balance are outlined by Shattuck (1996) in his descriptions of command and control issues during Israeli 1956 Suez Campaign and the British Battle of the Somme in World War I. He contrasts the highly centralized British approach at the Somme with the almost entirely decentralized approach of the Israelis to the 1956 Suez campaign as examples that either extreme carries the risk of failure. At the Somme, momentum was lost when circumstances changed, control was too tight, and subordinates had too limited an awareness of higher intent. At Suez, synchrony was lost because control was too loose and resources too tight. Shattuck (1996) cites Field Marshal Slim, British commander of the campaign in Burma in World War II, as saying that whereas he (Slim) always wrote his own statement of intent, he never wrote his own plans, relying on his planning team to interpret his intent, make plans, and write orders. This aspect (i.e., the importance of a commander's intent for planning teams) seems as crucial to successful mission outcomes as a common understanding of intent during implementation of the operation itself.

A related thread, common throughout the "lessons learned" interviews for Desert Storm, was that final plans were not the sole product of the staff but amalgamated from ideas from all units , which were acquired when plans were war-gamed, rehearsed, and back-briefed (*Leadership and Command on the Battlefield - Just Cause/Desert Storm*, 2000). Most commanders believed that there came a point in an operation at which commanders must resist the temptation to fine tune their plan and, instead, to fix and place the plan in the hands of subordinate leaders. This should be done with plenty of time to spare so that subordinates can finalize their own planning (including the development of the commander's statement of intent). However, the luxury of time to plan centrally and acquire feedback in this way may be the exception. Lack of time places an extra burden on the existence of pre-existing common understanding and procedures within the formation(s) responsible for the mission.

Commanders in Desert Storm emphasized that there needs to be more attention paid to the "...the understanding between captains and colonels that make coherent operations possible when the regiment ... fights. ....the implicit part of command and control and battlefield leadership." (Don Holder: Commander 2nd Air Cavalry Regiment Desert Storm) (*Leadership and Command on the Battlefield - Just Cause/Desert Storm*, 2000). This includes increasing the understanding between commanders two or more levels apart. "The primary element of command and control is .. command. This is accomplished with the knowledge of one another, an understanding of intent, a common level of knowledge in doctrine, and a common heritage of thinking and going to war." (Paul Funk: Commander 3rd Armoured Division, Desert Storm) (*Leadership and Command on the Battlefield - Just Cause/Desert Storm*, 2000). Commanders reported that, regardless of level, understanding of doctrine and the associated discipline of a common terminology is essential to implementation of tactics in the battlefield as well as facilitating rapid execution of orders without excessive discussion or misinterpretation.

In comments on preparation for Desert Storm, several points were made that relate to utility and application of the concept of Common Intent. For example, "Understanding .... intent is bigger than the rehearsals and back-briefs conducted in theater in preparation for battle. It starts at the home station the day the commander takes command. Training exercises, ...plans, standardization..., all give commanders and units an inherent mindset on how the unit fights." (J.H. Binford Peay III, Commander 101st Airborne Division, Desert Storm) (*Leadership and Command on the Battlefield - Just Cause/Desert Storm*, 2000). For combat, the consensus was that the commander's intent must be clear and simple and the vision that must be absorbed by the unit so that it can achieve its mission.

Based on the preceding discussion, we see that the military use of the term "command intent" is long established and something required at all levels of command. Command intent is the broad concept of the purpose, general methods, and constraints pertaining to a particular operation This should be distinguished from more specific products of the planning process, such as a commander's statement of intent, which is a communication conveying some parts of the command intent.

Command intent is seen as both an event and a process. As an "*event*" it is seen as an explicit mission related statement made in a certain format at a certain point in a mission sequence. There is an emphasis on the need for brevity and clarity so that the statement is memorable and easily recalled under difficult conditions. It is used by subordinate commanders and their planning teams as a point of reference for developing their own statement of intent, for planning their own mission, and in action during execution of the mission, especially when any original plan falters. Intent statements are seen as hierarchical with a need to be directly related to the intent statements of superior, subordinate and lateral commanders. Thus, for any given operation, there will be a series of inter-related statements of intent as each commander at each level relates their own intent statement to those above, below and laterally placed in the chain of command (see Figure 4.1).

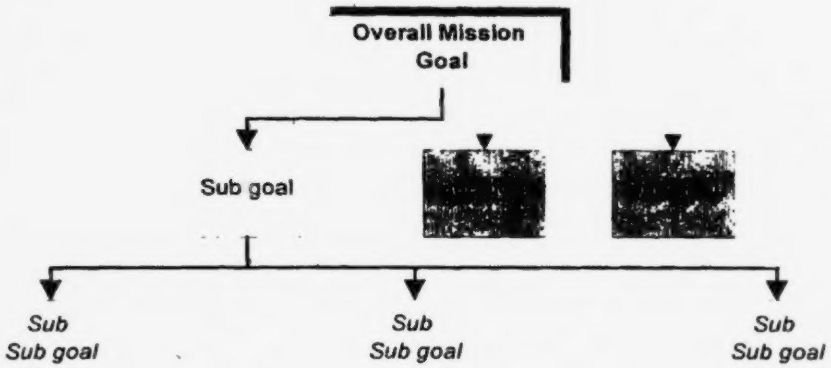

**Figure 4.1 - Statements of Intent With Respect to Hierarchical Command**

As a *process*, successful implementation of the actual "intent statement" is seen as dependent on activities both before and after the formal statement of intent

Long-term preparation of personnel is seen as crucial to success of any specific mission. Within and between military organizations, there is a need to build common understanding among all participants of doctrine, procedures, and vocabulary as well as capabilities long before any specific mission is envisaged.

Notwithstanding such long-term preparation, success in any particular mission must also be based on mutual comprehension among all participants of mission specific implications of each explicit statement of intent. This is achieved through formal and informal activities such as iterative feedback (such as back briefings) and rehearsal. The preparation of the intent statement, the specific plan based upon it, and the implementation of the mission in event of plan failure (sometimes described as almost inevitable) in the face of unforeseen circumstances, are seen as parts of a collaborative process among commanders at all levels. Intent statements may also be used to filter or fuse information appropriately for superior or subordinate commanders during an operation.

The main dimension along which military opinion seems to vary is the degree of control or centralization needed to ensure appropriate synchronization of effort. Historically, the range seems to be from virtually none to total control. The choice seems to depend on the traditions of the time and the culture, and the perceived needs of the operation.

## 4.2 Intent as a Theoretical Concept

The military use of the term *Command Intent* can be contrasted with use by Pigeau and McCann (1995, 2000) in their theory of *common intent*.

Stemming from their concern that the term *Command and Control* has lead to an over emphasis on technological solutions to *Control* that lose sight of human centred issues of *Command*, Pigeau and McCann start by offering separate definitions of command and of control.

> **Command**: "The authoritative and responsible expression of creative human will for the attainment of a mission."
>
> **Control**: "The application of structure and process for the purpose of bounding the mission's problem space."

These definitions more clearly distinguish the authority aspect of command from the coordinating aspect of control and lead to the following definition of C2:

> **Command and Control (C2)**:
> "The establishment of common intent to achieve coordinated action."

Although this definition of C2 puts the human element of command on equal footing with the process of control, it raises the issues of what constitutes intent and how intent functions to guide action. A brief outline of some key concepts from Pigeau and McCann is provided below.

As part of a broader perspective on command, intent is seen as the general connotation of an specific purpose. This general intent is divided into two parts, *explicit* intent and *implicit* intent. Explicit intent is publicly communicated directions such as written or verbal orders that convey a plan; i.e., not just a commander's statement of intent, as in military usage. However, even with lengthy directives, some intentions and details of how intentions are to be implemented are assumed, left to unspoken expectations, or referred to only at a higher level with the details unspecified. This leads to the complementary concept of implicit intent

Implicit intent, in contrast, is internalized collective and individual knowledge, expectations, and beliefs that may never be directly expressed, though it may be presumed upon to guide actions, consciously or otherwise. Given the natural limitations of any language or vocabulary, even an explicit communication cannot convey all the information intended by a sender. Interpretation of an explicit communication will always be based on a rich network of implied meanings that qualify and elaborate the particular words. Thus, the concept of *implicit intent* refers to all of the connotations latent in an explicit communication. Implicit intent derives from the extensive knowledge bases people acquire through experience, such as beliefs, values, habits, expectations, and personal styles, in or out of the military

Thus, overall *common intent* is derived from explicit and implicit intent and may be seen as the sum of all shared knowledge (however acquired) related to the implementation of a specific mission. This collective knowledge includes both goals and means and can be shared among many people representing different specialties. The term "knowledge" also encompasses attitudes, values, and beliefs that make up the affective aspect of intent Implicit intent is seen as especially important when the mission must be achieved in the face of unforeseeable and unexpected changes, or directions must be communicated briefly under extreme time pressures.

The composition of overall intent (explicit and implicit) within an individual is described in terms of an *intent hierarchy or pyramid (see* Figure 4.2*)*. Figure 4.2, depicts the relative importance and influence of the different components of intent proposed by Pigeau and McCann.

The top layer of explicit knowledge is derived from communications such as orders or directives related to the mission in question as well as dialogue about the mission in the form of discussion, questions, and answers. This is seen as the most visible but smallest and least influential layer.

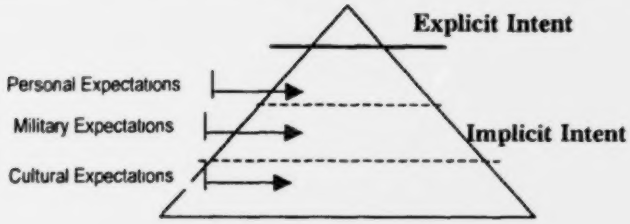

**Figure 4.2 - Intent Pyramid (Adapted from Pigeau & McCann, 2000)**

This explicit layer builds on further layers of implicit expectations based on personal, military and cultural education, training, and experience. These include, for example, expectations of how specific military procedures associated with the explicit orders should be executed. The personal layer is based, in its turn, on a larger, more influential layer of general military expectations. The military layer is comprised of doctrines and traditions that govern expectations about how to conduct oneself and relate to others and how operations should be carried out in general, not just specific orders for specific operations. Finally, this military layer is based on the broadest cultural expectations about national interests, societal and moral values. The lower the layer, the earlier its acquisition and the more enduring and resistant to change it is expected to be

Although depicted as a pyramid, there is no a priori evidence that the relative degrees of influence of the three implicit layers are distributed in such an orderly fashion. In fact, the three layers are closely inter-related. Military organizations are created within a set of cultural expectations, although they may develop in ways different from the culture as a whole. Likewise, people are greatly influenced by the culture in which they are born and live. A culture, however, changes over time as the result of the influences of all the individuals and institutions that make it up. Thus, it can be difficult to relate any aspect of an individual's or group's beliefs, attitudes, or values exclusively to one particular layer of expectations.

### 4.2.1 Sharing Intent

For a group or several groups of individuals to work toward a common end through coordinated C2, intent must be shared within and between teams in the organization. Explicit and implicit intent are assumed to be shared between people in different ways.

Explicit intent is shared through explicit communication in some form (usually written or verbal directives).

In contrast, sharing implicit intent is seen as a long-term preparatory activity that must be supported by the whole military organization. Organizations must support development of *shared* implicit intent by supplementing formal activities such as education and training in doctrine and procedures with opportunities for team building and personal interaction. These activities convey implicit knowledge, expectations, and values that people internalize.

Implicit intent may be acquired without conscious effort or awareness. Individuals are influenced by others who have subjective value and importance. Through repeated and prolonged interaction, individuals learn what others believe and value and begin to take on those beliefs and values themselves. The process, however, is not exclusively implicit. People or organizations may consciously promote or seek opinions and views of others to achieve consensus.

Four ways are proposed by which individuals can share their intent, although these four ways seldom operate in isolation one from the other. First, *dialogue* is a means of sharing *explicit* intent. Through reciprocal communication, specific mission related information is conveyed about objectives and processes. This presumably occurs during activities such as rehearsals, planning meetings, and mission related training as well as briefings, questions, and answers.

*Socialization* is a means of sharing one's *implicit* intent whereby one person observes another and draws conclusions about the beliefs, goals, and capabilities of others. Socialization may be based on non-verbal social interaction or occur during dialogue as one "reads between the lines" or observes the demeanor of the person providing the explicit communication. It is a relatively slow process requiring many exposures in many different contexts.[6] Examples might include membership of sports teams and participation in unit training exercises, or meeting friends.

*Externalization* is a means of sharing one's *implicit* intent through creative or expressive acts, such as the use of metaphor, anecdotes, or demonstration of a problem solving approach Such acts derive from one's rich implicit understanding and even intuition. Once expressed, one person can consider what had previously been concealed or implicit within another's intent hierarchy or pyramid. A military equivalent might be the sharing of "war stories."

Finally, *internalization* is the process whereby each of us integrates *explicit* information from others (whatever the medium of communication) into the implicit levels of our own intent hierarchy or pyramid. This process might be active or unconscious.

### 4.2.2 Common Intent

*Common intent* for a given group is seen as the sum of all shared mission relevant knowledge, however acquired. Establishing common intent is seen as critical for an organization to coordinate goal related efforts because common intent serves as a referent for members of the organization. They are able to compare the state of the mission at any given time to the common intent and then take any corrective action needed to ensure the organization's actions are working toward that intent.

The extent to which and the manner in which common intent is achieved are seen as related to a number of factors. These include the degree of centralization within an organization and the style of leadership. For example, more central organization requires more explicitly expressed intent in the form of written orders, rules and regulations. The degree of centralization within a given organization may itself fluctuate according to the type of mission, the experience of the organization with that type of mission, familiarity with the context of operation, and the longevity of the relationship of the members of the organization. Thus, members of a unit that has long experience of conventional warfare procedures working among Canadian army units in a European theatre may need less explicit direction than the same unit working for the first time on a peace keeping mission in a strange country as part of a multi-national force in collaboration with different civil organizations.

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[6] It is important to observe another person's actions on several occasions in different contexts to identify the beliefs and values that seem to be consistent to that person A single instance of behavior in one context may reflect a wide variety of situational factors that do not reveal anything about the person's internal beliefs

Although outside the scope of this review, different styles of leadership are also seen as associated with different patterns of sharing explicit and implicit intent with distinctions between autocratic, charismatic, and transactional leadership styles. There is also the possibility that a given leader may adopt a different style based on expediency. For example, the same person may adopt a more autocratic or charismatic style with inexperienced than seasoned troops or when the unit is under more stressful and time constrained circumstances.

## 4.3 Theory Versus Practice

Traditional military usage of the concept of intent shares certain core characteristics with Pigeau and McCann's formulation. Both acknowledge the importance of all mission participants comprehending the intent of the appropriate level of command for a successful mission outcome. Both accounts propose that intent should be shared among individuals for success in an operation. Both argue that the foundation for a common understanding of command intent must be laid long before a given mission.

More specifically there is broad agreement that:

- Shared intent is critical for people to work together effectively to a common end.
- There needs to (or will) be some explicit formal statement of intent for any mission.
- Common comprehension and implementation of mission intent is based on implicit understandings among team members; i.e., shared values, attitudes, knowledge, procedures, and skills within and between individuals and groups.
- Such a shared implicit cognitive infrastructure can be acquired by different routes through common experiences, education, or training.
- The foundation of a shared or common outlook must be started long before it is required for any mission. This is achieved partly by common long-term training such as doctrine, vocabulary, and procedures, partly by medium-term team building activities for personnel who may have to work together on the mission, building on their common background, and, finally, short-term planning and rehearsal among the team that will actually go on the mission.
- Coordinated action under difficult, stressful and changing circumstances is more likely to occur and be successful where there is a common understanding of intent.
- A common understanding needs to work laterally as well as vertically within and between cooperating organizations.
- When assumptions about common understanding are misplaced (vertically or laterally in the organization), then mission implementation will likely falter as a result.

However, there are some key differences and ambiguities between military practice and the theoretical position of Pigeau and McCann. Some differences can be seen in terms of the broader scope of Pigeau and McCann and their focus on the psychological and cultural processes affecting implicit and explicit understanding among individuals and groups. These differences are discussed in detail in the subsequent sections. In relation to the military concept of command intent, Common Intent is broader and more general.

> **Common intent** refers to the degree to which the complex framework of values, attitudes, knowledge, and practices of an individual has elements in common with that of other individuals.
>
> **Command intent** refers to the purpose, desired result, and approach to conducting a particular mission in the mind's eye of a commander.

The degree to which the individuals under command have common intent among themselves and with the commander is proposed as a key factor underlying mission success. The greater the degree of common intent, the greater should be the probability that the group will work together effectively and efficiently. Moreover, the greater the degree of common intent, the lower the probability of misunderstanding and/or uncoordinated actions among individuals, especially in the face of unexpected circumstances.

The term command vision is sometimes attached to the idea of command intent and it reflects the notion that command intent is the overarching mental structure for a particular operation. Command intent is expressed through a number of specific means, as prescribed by military procedures. One such means is the commander's statement of intent, which is a document that expresses some aspects of the command intent (we assume that any statement will cover only a limited portion of the command intent). This communication, like any other, will represent a selective balance of implicit and explicit intent based on the communicator's assumptions about pre-existing common intent

### 4.3.1 Intent hierarchy

The term '*intent hierarchy*' is used in different and potentially confusing ways by the military literature and Pigeau and McCann.

The military view of an intent hierarchy is of an interlocking relationship among explicit command intent statements for a given mission, at different levels of command. Subordinate commanders are explicitly expected to take into account the intent statements of superior and lateral commanders when preparing their own plans or reacting to unforeseen circumstances. Command intent statements are expected to dovetail as different components of a higher level mission are delegated down the chain of command. The military literature refers to the need for the commander at any given level to know and comprehend the command intent two levels up. There is also allusion to the need to comprehend intent statements of groups laterally placed within the organization in order to coordinate adjacent operations Part of the overall purpose is to provide guidance in the event that a unit has to abandon its own mission and figure out what to do in relation to other units.

Pigeau and McCann use the term '*intent hierarchy*' quite differently to describe the expectations and understanding of the meaning of the goals and manner of implementation of a particular mission. A large factor in these expectations and understanding is the influence of personal, military, and cultural roots.

We suggest substitution of the term "*intent pyramid*" within the theory of Common Intent. Pigeau and McCann do use the term "*pyramid,*" and it does seem closer to their intended metaphor. A pyramid is built on strong foundations with a greater mass or weight at the base whereas a *hierarchy* suggests a top down delegation and implies organization rather than substance, and is more appropriate for the military usage. *(This suggestion will be implemented for the remainder of this report and the term intent pyramid used to distinguish between the concepts.)*

### 4.3.2 Explicit or implicit

Military discussions tend focus on explicit intent; i.e., the commander's statement of intent. The military view of command intent is that it *must be* explicitly communicated. The commander's statement of intent is a key component of mission orders, the mission statement, and concept of operations at all levels of command. This view appears to be shared by different nations, though there may be differences in format, scope, and degree of latitude for individual initiative. The military literature, however, also recognizes that understanding and implementation of a commander's explicit intent relies on shared knowledge and background (i.e., implicit understanding) and provides for building this.

### 4.3.3 Scope

The military literature describes the format for expressing command intent in terms of the mission purpose and desired outcomes and, possibly, the outline of a plan or concept of operations to accomplish those aims. Intent is quite specifically delimited and separated from other aspects of orders that deal with the method of implementation in more or less detail.

There is an emphasis on telling subordinates only what they need to know, without recognizing that there can be different perspectives about what is important. Quite possibly, subordinates need to be involved in achieving the right balance of relevant information and should be provided ready access to further information, should they require it.

Pigeau and McCann's scope for the term intent is far broader than the military usage and goes beyond purpose and desired end state to include all knowledge related to mission implementation. This suggests that there is a need to subdivide their concept of explicit intent further to distinguish between the Commander's Statement of Intent (i.e., purpose and desired end state), and all other explicitly communicated mission related information.

### 4.3.4 Format and Responsibility

Within the military, role responsibilities for the generation and use of statements of commander's intent are quite well defined. For instance, commanders are expected to generate statements of intent but not plans, and to monitor missions in terms of purpose and outcome, not procedures, the responsibility for which is delegated to others. The statement of intent is the responsibility of the commander, but may be the product of a command team. Pigeau and McCann, however, do not address the matters of format or role responsibilities.

### 4.3.5 Intent: Purpose and/or Means

The military limit the use of the term "Intent" to a explicit statement of the purpose of the mission and the desired end state: the means of achievement is either excluded or dealt with in brief outline. The goal of the intent statement for the military is to provide a guideline for planning and then implementation, especially in the face of unforeseen circumstances that render the original plan ineffective or redundant.

Pigeau and McCann take a much broader view and include in '*common intent*' the sum of all mission related information, explicit or implicit.

- *Explicit intent* is seen as much more than the collective statements of commanders' intent and covers all explicitly conveyed mission directives.
- *Implicit intent* covers all the unspoken but assumed relevant mission expectations about the way in which explicit directives will (or will not) be carried out.

In the dictionary, the term *intent* is more or less synonymous with words such as purpose, design, end, aim or objective but also indicates meaning, purport, and connotation. In the theory of Common Intent, the connotation of the term intent goes beyond this to include all knowledge leading to achievement of the purpose (i.e., to include the meaning.) and to address the common understanding or comprehension of all mission relevant matters (i.e. more than just purpose). For example, Pigeau and McCann contrast centralized and decentralized organizations in terms of the extent of written orders, rules, regulations, guidelines, procedures, detailed operational orders, all of which they see as forming the preponderance of explicit intent. Centralised organizations are characterized by a greater degree of explicitly expressed intent and decentralized organizations by more implicit intent The theory of Common Intent suggests that a high degree of shared implicit intent will promote effective C2 and mission performance. Extensive shared implicit intent, however, may not exist, making it important for the theory to distinguish ends and means, both implicit and explicit. Consequently, the theory needs to be broadened to include all mission relevant knowledge such as procedures, as presently implied.

The theory of Common Intent relates as much to coordination of team members' efforts towards the achieving of a common goal as the communication and sharing of the understanding of that goal There is a need to distinguish between these two aspects.

- First: does everyone understand and share a common vision of why we are doing something and how we want to end up (command intent).
- Second, does everyone know how we are going to work together to achieve the goal, under whatever circumstances come our way (common intent).

Unfortunately, this would require a change to Pigeau and McCann's definitions. The suggestion below assumes that the military use of the term *intent* is of the longest standing and should stay. Accordingly a modification to Pigeau and McCann's definition of C2 might be:

> *The transformation of command intent (i.e., purpose and desired end state) into coordinated action through the establishment of common intent.*

This still leaves some confusion over the different uses of the word intent. *A* key here may be another Pigeau and McCann definition, that of common intent . Namely:

> *The sum of shared explicit intent plus (operationally relevant) shared implicit intent.*

A critical underlying concept is that Common Intent represents all the operationally relevant knowledge needed to implement the command intent for the mission (one assumes that explicit intent must, by definition, be operationally relevant). This suggests that the most appropriate term would be one implying all mission relevant knowledge needed by the group in question (however acquired), such as "*mission awareness*[7]". If so, then the definition could become:

> *Mission Awareness: the sum of explicit and implicit information necessary to achieve command intent.*[8]

### 4.3.6 Implicit: status or process

The term *implicit* has some ambiguities. Once an explicit statement is made, the sender is likely to assume that the receiver will retain it all (i.e., completely and accurately) and act on that information appropriately; i.e., the knowledge is assumed to have become implicit and does not need to be repeated. The sender will then rely upon that assumption. However, a person may also acquire knowledge implicitly, for example by watching another's mistakes. Regardless of how the information is communicated or shared (explicit or implicit), the consequence is that, at some level of completeness and accuracy, that information may now be assumed to be implicit. Thus the term implicit doubles for:

- the manner of communicating, learning, or sharing of intent, and
- the status of intent once communicated, in the minds of both the sender and the receiver.

The latter connotation (status) seems to carry more added value than the former (learning), which seems to overlap largely with the concept of tacit knowledge.

## 4.4 Research Implications

Based on the literature reviewed, there are several forms of intent, ranging from the very general common intent, through command intent, to specific externalizations of command intent, such as the commander's statement of intent. Thus, it is critical to identify exactly what kind of intent is under consideration. The literature also makes clear that, although an individual can possess common intent or formulate command intent, these concepts apply more to groups of individuals. It is the sharing of knowledge, values, attitudes, and so on that makes common intent a vital component of C2.

The literature reviewed raises a number of issues, which we have summarized these issues in terms of practical research questions. An important prelude to any research will be to:

- Resolve the issues of scope and terminology outlined above.
- Determine the focal point: common intent as solely goal related, or including all mission related matters. The former would appear to be both more manageable and more appropriate to the current trend towards OOTW in which diverse organizations with diverse procedures will become the norm.

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[7] The term Mission Awareness would also have to be distinguished from the more common Situation Awareness (SA). The former is seen as much more inclusive than the latter (SA) which is seen as more related to spatial factors and immediate events

[8] Naval OROs (Matthews and Webb, 1999) repeatedly prefaced explanations of how they would respond to events by saying that they had to judge what they must do, or predict what other ships or aircraft in the Task Group would do, by reference to the overall mission

- Determine the type of mission and the level in the organization(s) level at which any research is going to focus. This decision should take into account trends in the types of operations that will be expected of the Canadian military, for example OOTW.

In general terms, it appears appropriate for further research to:

- Focus on command teams rather than the person of a commander. Command decision making is rarely exercised outside the context of a team. Furthermore, in a multi-level, multi-specialty organization such as the military, individuals may be members of a command team at one level, and leaders of their own command team at another. There may even be occasions where individuals have to reconcile the conflicting intentions of two different authorities, for example when a technical specialist must decide between fulfilling the intent of either their technical or their operational commander. Such organizational frameworks need to be better understood.
- Focus on the individual "mission" and its context as a baseline. Whether couched in military terms or within the theory of Common Intent, the goal is a common understanding for a single mission. This, in turn, raises important issues concerning how that understanding affects mission performance and how such a common understanding is best acquired and supported. The concept of *common intent* being the sum of explicit and implicit intent required for achievement of a particular mission implies that, for different missions with different participating groups, the required content of such common intent will vary.
- Focus on command intent and the process of transferring such knowledge from one person to another in terms of the effectiveness of the transmission, the appropriateness of the means (does it provide all the detail required), and its efficiency (bandwidth demands, time to transmit, etc.). For example, differences in terminology among specialties in a diverse team may result in less effective exchanges of explicit intent (i.e., more misunderstandings) and the level of misunderstanding may be greater or less likely to be revealed for different mediums (e.g., face to face discussions versus digital information exchanges).
- Examine the implications of within-team diversity and choose to study a level of military organization and a type of mission that represents an appropriate level of within-team diversity in terms of specialist background and levels of empowerment. Although some issues may be studied initially in a simple, single-specialty setting (e.g., infantry section), this should be seen as a prelude to examining greater levels of within-team diversity. Command or management teams with more diverse cultural, personal, or specialty backgrounds can be expected to share less common implicit intent, to have more potential for misunderstandings to arise and for there to be greater differences in the interpretation of any given explicit communication. As diversity in a group increases, the level of explicit communication with respect to specific mission needs can be expected to rise; i.e., more discussion, more rehearsal. For example, a combat team command group comprising specialists from the infantry, armour, artillery, engineers and others will have more difficulty in achieving common intent than a team drawn from only one of these specialties. In the more diverse group, despite their common army background, the different traditions, training, and operational roles of the specialist arms will need to be

> bridged. Added to this, differences in rank and years of experience of the command team members may be considerable. Junior engineer or artillery lieutenants may have to represent their technical specialty to a senior infantry major. A single arm unit will be less diverse. A joint service organization will be more diverse Greater diversity within a team may pool a greater range of cognitive resources for the mission at hand, but the benefits of this greater knowledge base may be counteracted by a higher probability of internal misunderstanding and within team conflict. In terms of the intent pyramid, the deeper the roots of the difference, the more difficult should be the resolution of the person-person conflict.

The balance between explicit and implicit communication may also vary according to the needs for synchronization, the diversity (specialties, services, nations) among the group(s), whether they have worked together before, familiarity with the location and the type of mission, and the inherent technical complexities of the type of mission.

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# 5. Intent Pyramid: Content and Structure

The concept of the intent pyramid occupies a central position in the theory of Common Intent. It is the knowledge representation upon which an individual draws (consciously or unconsciously) to plan and make decisions in the C2 context. The intent pyramid is also the basis of sharing intent, determining what is shared and, to a large extent, how it can be shared. In this section, we review research that elaborates the content and structure (organization) of intent pyramids. To do this, we draw upon the literature pertaining to command concepts, team mental models, tacit knowledge, and embedded and embodied knowledge.

## 5.1 Command Concepts

By posing the question *"What would a commander have had to tell his subordinates before the battle to have made their subsequent actions conform to his concept,"* Builder, Bankes, and Nordin (1999) developed a set of elements that comprise the information essential to a command concept. At a minimum, Builder et al. believe a command concept or vision of the prospective operation should include:

- Time scales that reveal adequate preparation and readiness, not just of the concept but of the armed forces tasked with carrying out that concept.
- Awareness of the key physical, geographical, and meteorological features of the battle space - situational awareness - that will enable the concept to be realized
- A structuring of forces consistent with the battle tasks to be accomplished.
- Congruence of the concept with the means for conducting the battle.
- What is to be accomplished, from the highest to the lowest levels of command.
- Intelligence on what the enemy is expected to do, including the confirming and refuting signs to be looked for throughout the coming engagement.
- What the enemy is trying to accomplish, not just his capabilities and dispositions.
- What the concept-originating commander and his forces should be able to do and how to do it, with all of the problems and opportunities - not just the required deployments, logistics, and schedules, but the nature of the clashes and what to expect in the confusion of battle.
- Indicators of the failure of, or flaws in, the command concept and ways of identifying and communicating information that could change or cancel the concept.
- A contingency plan in the event of failure of the concept and the resulting operation.

Thus, Builder et al. lay out a number of very specific kinds of information that must go into a command concept[9]. This information further defines the sum of knowledge required by subordinate commanders on which they will base their own planning and execution, and which will act as a filter for the exchange of essential command related information before and during the battle. In Builder et al's view, the ideal communication system from the view point of command will limit traffic to that which answers essential questions to do with the command concept such as *"Are things going as*

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[9] This list of command concepts might be used as part of a framework for the content of total mission related knowledge that needs to be explicitly communicated for a specific mission

*envisioned? If not, what needs fixing? Why are things going wrong? Is the vision wrong or does it simply need some adjustment?"* Builder et al's catalogue of information goes beyond what is contained in "*Command Intent*" to deal with the "*Command Concept*" that underlies that more concise expression of the commander's expected outcome of the mission. However, Builder et al. stop short of the broader scope of the theory of Common Intent by seeking to separate command issues from more detailed implementation or "control" issues that they believe threaten to overload communication systems and commanders with irrelevant information.

To examine the validity of their theory, Builder et al. reviewed six historical cases. These cases comprised modern battles (within the past 50 years) that presented a clear C2 challenge. We will briefly describe just two of their case studies to illustrate their findings. Although all the cases considered concern large military operations involving many thousands of personnel, Builder et al. emphasize that the broad principle they advocate should apply at all levels from theatre commander to infantry squad. However, they do not indicate how their detailed catalogue of information might be decomposed as it makes it way down through a series of subordinate commanders. Neither do they comment on what is possibly more important, how key information affecting the progress of the vision of a commander higher up the chain of command might be recognized by a subordinate several levels down and/or reconstituted as it works its way back up.

One case was U.S. Admiral Nimitz's conduct of the Battle at Midway during World War II. The Japanese Navy planned to attack and occupy Midway Island at the extreme end of the Hawaiian Island chain. One goal was to draw U.S. naval forces into a decisive battle. U.S. Navy cryptographers, however, had intercepted and decoded fragments of coded Japanese naval communications. As a result, they were able to deduce the outlines of the Japanese plans. On the basis of the intelligence available, Nimitz drew up an operational plan to defend Midway Island.

Builder et al.'s assessment of Nimitz's conduct of the Battle of Midway was that it was an almost perfect instance of the command concepts theory. Nimitz developed a sound and detailed concept based on accurate intelligence that was then thoroughly communicated to subordinates through a detailed operational plan, together with appropriate indicators of the failure or flaws in the command concept. As a result, there was little need for C2 communications during the execution of the operation. Builder et al. suggest that Nimitz could have remained behind when the carriers departed Pearl Harbor and, given that the intelligence was correct, his concept would have been sufficient to ensure victory.

A second case study examined a somewhat less successful command concept, Field Marshal Montgomery's MARKET-GARDEN operation during World War II. The two objectives of this operation were to move Allied forces across the River Rhine and to capture or neutralize Germany's industrial heartland. Allied intelligence had rated the capability of German forces to oppose the operation as low, given that German units were retreating toward Germany in various stages of disarray. Montgomery's plan was to drop the main combat elements of three airborne divisions in the vicinity of Arnhem. These forces would be reinforced with subsequent drops as it moved to Arnhem. In all, roughly 34,000 troops were to be dropped by parachute and 13,781 were to be landed by glider.

The Germans, however, had mustered approximately three panzer divisions throughout the corridor toward Germany and two additional panzer divisions in and around the town of Arnhem (a key objective of MARKET GARDEN). Several warnings of this German strength were dismissed in Allied headquarters.

Although Montgomery's plan had been extensively rehearsed and was well understood by all subordinate leaders, inadequate provision was made for communication of problems during the operation. General Dempsey, the overall ground commander, had no system for receiving indications that the plan was not proceeding as anticipated and Builder et al. note that the operational plan did not provide for identifying and communicating indicators that the command concept was not working. As a result, the Allies continued to drop troops and materials into the battle area long after it could have been clear that the German resistance was stronger than had been assumed and that the plan was inadequate to its task.

Although Builder et al.'s (1999) study is provocative and potentially very useful in elaborating the concept of command intent, there are few studies of this sort (but see also Connor, 2000, for another case study of establishing command intent). This raises concerns about the reliability of their analysis, which was based on only a few historical case studies. Historical analysis is highly subjective and other researchers with different perspectives may have identified a different set of command concepts common to all the case studies. In addition, Builder et al. focused primarily on successful operations, whereas unsuccessful operations may have yielded additional insights into key command concepts. Overall, this line of research deserves to be pursued in order to provide further evidence that clarifies the value and universality of the command concepts identified by Builder et al.

The old expression "fighting the last war" captures an historically validated truth - even a well-trained, efficient army can lose a battle if it operates according to an out-dated or inadequate concept of warfare. Put in context of common intent, even an army that communicates (explicit) intent perfectly can be defeated if that intent is inaccurate or inadequate in the context of the opposing forces. Many of the successes of the Axis powers during World War II may be more attributable to inadequacies of Allied doctrine or capability than misunderstandings or failure to share common understanding of the concept of operations. Examples might include the merits of air power at sea, or the manner in which armoured forces and air power could be best used on land. Indeed, too comprehensive and entrenched a common intent on the part of the professional armed services may have been at the root of many early defeats. This implies an "inverted U" relationship between common intent and mission success: too little or too much may prove counterproductive.

## 5.2 Mental Models

The concept of the *mental model* was developed as a means to describe complex and rich mental representations of knowledge (e.g., Johnson-Laird, 1983). The defining characteristic of a mental model is that it is organized. Moreover, it is organized in terms of the external environment or system that it models. Thus, a mental model contains elements that correspond to those elements making up the external system and the model elements are inter-related in the same fashion as the external elements. A mental model is certainly less detailed than reality, may vary in the form of representation, and often emphasizes certain elements and relationships over others but, nonetheless, serves as an internal simulation of external systems. The extent to which individuals share the same mental model for a common area of interest can be expected to affect the degree of coordination or simply behaviour in common - intentionally or otherwise.

Rouse, Cannon-Bowers, and Salas (1992) define mental models as: "mechanisms whereby humans are able to generate descriptions of system purpose and form, explanations of system function and observed system states, and predictions or expectations of future system states." In the context of command systems, it is important to note that mental models can represent highly conceptual systems, such as command structure. Modeled elements are not restricted to physical objects; they can refer to roles, beliefs, values, and other conceptual entities. Consequently, mental models can be used to represent and reason about common intent.

Researchers investigating the use of mental models in a team decision making and problem solving context have distinguished three kinds of knowledge making up team members' models; *task-related, team-related,*, and ***equipment***-related elements (e.g., Heffner, 1997; Mohammed, 1996; Rouse, Cannon-Bowers, & Salas, 1992).

- Task-related knowledge refers to representations of the specific tasks or problems confronting the team. Specifically, task elements include evaluative criteria, procedures, and strategies pertinent to the tasks and problems. In other words, a mental model of tasks informs team members how to perform their job within the team and how to address problems or events that may arise. However, discussion of where purpose or goals fit in is largely absent.
- Team-related knowledge refers to representations of the organization of the team, group processes, and the relationships between team members. Specifically, team elements include roles of team members, relationships, group norms, values, and other elements pertaining to the functioning of the team in question and teams in general. Expectations about the capabilities and attitudes of current team members can also be included (for example expert or novice) and will be related to concepts of trust and confidence. A mental model of the team informs team members how the team as a whole works and how they are expected to behave within the team setting. Team elements are crucial to coordination, communication, and information exchange within a team (Rentach et al., 1998). Experiences with past teams may be expected to carry over to new teams.

To task and team knowledge, Rouse et al. (1992) add:

- Equipment elements that refer to schematic or physical representations of equipment in the system of interest and behaviour of environmental components that affect the operation.

In common with others, Rouse et al. (1992) also propose that, for a given individual, mental models progress (through training and experience) from knowledge or principles through rules or procedures to skills (largely unconscious and routinized pattern recognition). As practice within a team increases, mental models are proposed to become more "compiled;" i.e., less consciously accessible to the user, and therefore less susceptible to articulation or reflection (and, by implication, less available to any researcher). As this progression evolves, team performance may continue to improve but without any apparent changes in the mental models of the team members. This suggests that a downside of well entrenched team mental models is that individuals become less able to respond adaptively to novel situations; i.e., an inverted-U relationship.

Although a shared mental model has been associated with better team performance, there appears to be a limit to the positive effects of commonality. When team members share too many beliefs and values, there is a danger that the team will exhibit "groupthink," a tendency to think and act strictly within narrowly preconceived views (Esser, 1998; Peterson, Owens, Tetlock, Fan, & Martorana, 1998). In many domains, however, creativity is a valuable characteristic of teams. Product development teams, for example, must generate new ideas to advance the larger organization's interests. Military C2 teams must generate plans that can achieve objectives without being easily anticipated by the enemy. Diversity within a team, in terms of education, technical specialty, role responsibilities, experience, attitudes, and so on, can enhance creativity (Knight, Pearce, Smith, Olian, Sims, Smith, & Flood, 1999). This suggests that a team's performance might follow an "inverted U" function with respect to shared mental models (Madhavan and Grover 1998). In other words, the more team members share mental models the better will be performance but only up to a point. Continued increases in sharing would lead team members to adopt too restricted a set of beliefs and lead to a lack of innovation. In the military context, a very high degree of shared mental models might also lead to the development of inappropriate, unworkable, or unlawful activities, which are perceived as adequate within the shared mental model of the team (see Winslow, 1998).

## 5.3 Tacit Knowledge

The concept of Tacit Knowledge (TK) has been used by Horvath, Sternberg, and colleagues (Horvath, Forsythe, Sweeney, McNally, Wattendorf, Williams, & Sternberg, 1994a; Horvath, Forsythe, Sweeney, McNally, Wattendorf, Williams, & Sternberg, 1994b; Sternberg & Wagner, 1991) in an extensive study of military leadership skills (not command) at the platoon, company and battalion level. The concept of TK is derived from Sternberg's distinction between academic and practical intelligence. Academic intelligence, as the name suggests, relates to formal declarative classroom knowledge. Practical intelligence is more concerned with procedures for dealing successfully with ill-defined everyday issues and acquired implicitly through observation and experience. Practical intelligence is also seen as implicit in the sense that it is expressed through strategic action rather than articulated.

Tacit knowledge is a component of practical intelligence and represents informal knowledge, acquired through observation and experience (i.e., apprenticeship), about how to solve practical problems. It is procedural, goal related, and acquired with little organizational support. TK is organized into systems of production rules (Anderson, 1995), which consist of sets of "*if this condition -then perform that action*" rules. Thus, TK can be thought of, loosely, as practical "how to" statements that guide performance in a domain. The production rules, however, can be quite complex, depending on the domain and the knowledge acquired by an individual. In any case, TK is largely implicit such that it is readily expressed through action but difficult to articulate verbally. According to Sternberg and Wagner (1991), TK can apply to three kinds of practical knowledge:

- Managing oneself (level of effort, motivation, capabilities)
- Managing others (strategies and procedures for working with others)
- Managing tasks (procedures, criteria)

Horvath and colleagues (Horvath et al., 1994a; Sternberg et al., 1999) developed a method to measure TK in a number of topics and domains, including leadership in the military. Their method is likely to have application to the study of Common Intent. This method establishes a TK inventory by first reviewing job-relevant literature and then conducting interviews with successful practitioners in that domain to identify the implicit rules, procedures, and information they use to solve problems. These interviews start with standard questions established during the literature review and progress to critical incident descriptions, in which the interviewee recounts significant job related learning experiences. The examples generated are then reviewed by an expert panel to compile condition-action paired items that meet TK criteria such as being procedural, goal-related, and acquired informally. Major TK categories are then identified by cluster analysis. Items are also rated in terms such as their value, how widely they are known, and how frequently they are faced. Items that predict success in the domain are then organized as a TK survey in questionnaire form. Such surveys have been developed for military leadership, business management, bank management, and sales.

There have been several studies that support the validity of the TK concept and its causal link to successful performance of individuals. The same general method has been used to examine TK in all domains (Sternberg & Wagner, 1991):

- Compare the strategies and rules of groups with different levels of experience in a domain.
- Design a test of TK based on the knowledge exhibited by novices and experts in the domain.
- Assess TK of an independent group with the test designed for the domain.
- Assess other variables, such as general intelligence and personality factors.
- Measure performance of a series of domain problems.
- Determine the correlations of the factors to performance on the domain problems to determine whether TK predicts performance and whether that predictive power is greater than that of other factors.

Based on this method, Sternberg, Horvath, and their colleagues found that subscales of TK (intrapersonal, interpersonal, organizational) correlate among themselves, although people tended to be higher in one aspect or another (Sternberg & Wagner, 1991). TK scores in one domain tend to correlate somewhat but not highly with TK scores in other domains, suggesting that there are some general aspects of TK but that most TK is domain specific (Sternberg & Wagner, 1991) [10] Most importantly, TK scores have been found to increase with experience and predict job performance, according to a variety of measures, for business managers, salespeople, academic psychologists, and bank managers (Horvath et al., 1994a; Sternberg & Wagner, 1991).

Horvath et al. (1994a) developed a TK survey for military leadership following the procedure described above. Interviews with 81 U.S. Army officers at the Platoon, Company, and Battalion commander levels yielded a large number of TK items relating to leadership (interviewees were specifically told that the focus was on experience, not doctrine or training). The TK items on the survey were sorted into categories and subcategories, as shown in Table 6.1, which shows general themes of the importance of cooperation, motivation, and dealing with the overall organizational structure.

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[10] TK scores exhibit a low correlation with general intelligence measures (e g , Intelligence Quotient, verbal reasoning), indicating that TK is a distinct construct (Sternberg et al , 1999)

| Category | Subcategory |
|---|---|
| Intrapersonal | Managing one's self |
| | Seeking challenges and control |
| Interpersonal | Influencing and controlling others |
| | Supporting and cooperating with others |
| | Learning from others |
| Organizational | Solving organizational problems |

**Table 5.1 - Categories and subcategories of TK in the TKS for Military Leadership (Adapted from Horvath et al., 1994a)**

Horvath, Forsythe, Sweeney, McNally, Wattendorf, Williams, and Sternberg (1994b) found that the company level produced more TK items than the platoon level. The battalion level, however, did not produce more items than the company level but battalion commanders did exhibit the greatest level of differentiation among TK items, indicating the highest level of complexity.

Specific comparisons among levels of command revealed five kinds of TK common to all levels:

- Communicating
- Managing the self.
- Motivating subordinates.
- Establishing trust.
- Taking care of soldiers.

One class of item, influencing the boss, was common to the platoon and company levels, whereas another class, developing subordinates, was common to the company and battalion levels. Classes of items specific to a particular level are shown in Table 6.2.

| Level of Command | Classes of TK Items Specific to the Level of Command |
|---|---|
| Platoon Leader | Establishing credibility |
| Company Commander | Directing and supervising subordinates<br>Cooperating with others<br>Balancing mission and troops |
| Battalion Commander | Protecting the organization<br>Managing organizational change<br>Dealing with poor performers |

**Table 5.2 - Classes of TK Items Specific to a Particular Level of Command (Adapted from Horvath et al., 1994b)**

The kinds of TK acquired at each level of organization were believed to reflect the unique demands placed on leaders (Horvath et al., 1994b). Platoon leaders have limited experience and little power. Consequently, they must develop credibility with subordinates and superiors to accomplish their duties. Company commanders have more experience and power, as well as more discretion in deciding how to accomplish a mission. As a result, more of their job involves coordinating with the battalion staff and balancing mission goals against the interest of the soldiers in the company. Battalion commanders have extensive experience and considerable power and discretion. They lack the ability to lead face-to-face and so work more with the organization as a whole. Battalion commanders must be more future-oriented as they manage a larger organization.

Sternberg, Horvath, and their colleagues undertook their study of TK in the military domain with the clear purpose of exploring military *leadership*, not *common intent*. According to Pigeau and McCann, leadership is a related but distinct concept to common intent, one that pertains to the ways a commander may influence others. Horvath et al. (1994b) did include among the classes of TK for military leadership such items as supporting and cooperating with others and solving organizational problems, which relate to the kinds of team processes supported by shared intent. Thus, the TK items identified through officer interviews by Horvath et al. (1994b), and perhaps leadership issues as a whole, can be considered ancillary to the sharing of intent and more concerned with control methods than command goals.

## 5.4 Embedded and Embodied Knowledge

Madhavan and Grover (1998) have developed a framework for distributed cognition within organizations using New Product Development (NPD) teams as a focal point. NPD teams are multidisciplinary teams that work on large-scale, ill-defined problems the solution of which requires the knowledge and input of individuals with disparate expertise, often representing different technical departments within an organization.

These authors examined how organizations can best manage the generation of new knowledge through the synergy of the specialist knowledge of individual members of an organization. They expanded upon the Sternberg and Horvath concept of tacit knowledge of individuals (i e., difficult to express, transferred by apprenticeship) to include informal rules and procedures of organizations (corporate memory, organizational blueprints). Madhavan and Grover defined *Embedded Knowledge* as the knowledge that results from the combination of individual team members' stores of tacit knowledge; i.e., the relevant collective tacit knowledge of a diverse cross-functional group. It is important to note that much of this embedded knowledge remains latent until someone attempts to combine what team members know. Thus, embedded knowledge is one component of shared knowledge and whereas sharing knowledge of which one is consciously aware is seen as relatively easy, sharing tacit knowledge is difficult  Indeed, sharing tacit knowledge depends on several factors.

In the context of NPD teams, *Embodied Knowledge* is described as embedded knowledge that has been incorporated into the design of a new product. Thus, the major goal of NPD teams is to manage the transition of embedded knowledge to embodied knowledge effectively and efficiently.[11]

Although studies have indicated that shared TK can benefit team performance (Horvath et al., 1994b; Sternberger & Wagner, 1991), Madhavan and Grover (1998) argue that TK must be made explicit, or consciously available, in shared mental models to truly enhance the creativity and productivity of teams. To explore these concepts, Madhavan and Grover (1996) examined the literature concerning the functioning of NPD teams and interviewed managers and team members to derive a number of research propositions

Two groups of factors govern the effectiveness of the transition from embedded to embodied knowledge. *Exogenous* factors are related to the selection of team members, whereas *endogenous* factors are related to management support, organizational culture, and the resources provided.

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[11] *Effectiveness* is defined as the degree to which the new product meets the needs of the customer  *Efficiency* is defined as the amount of resources used to for the degree of effectiveness achieved

Exogenous factors include two classes of skills that members can bring to the team. Those with "T-shaped" skills possess technical knowledge and expertise in a discipline (the vertical) and skills for interacting with individuals from other domains (the horizontal part of the "T"). Team members with T-shaped skills contribute to effective transitioning to embodied knowledge by contributing their expertise and sparking creative conflict with members from other domains. In contrast, those with "A-shaped" skills possess technical expertise in more than one discipline (the two diagonals of the letter "A") and the capability to link those two disciplines and combine technical insights (the bar of the "A"). Madhavan and Grover (1996) argue that A-shaped skills are particularly valuable for a leader of an NPD team because they facilitate combining different areas of technical knowledge at a high level of sophistication. Speculatively, military commanders, especially of multiple arm, joint service or OOTW missions, need both types of skill.

A third exogenous factor is the extent to which team members possess a shared mental model and shared TK within the product development domain. These provide a common language and common principles for teamwork and should contribute to effective embodiment of knowledge in a product. Madhavan and Grover (1996), however, note that too much shared cognition can result in "groupthink" and a lack of creativity. Differences in views, they argue, are needed to spark new ideas and approaches. This leads to their proposal of a curvilinear or inverted-U relationship between the degree of shared mental models and the effectiveness of the transition of embodied to embedded knowledge.

Endogenous factors also affect the transition from embedded to embodied knowledge, which can affect NPD team effectiveness. One endogenous factor is *Trust in the team orientation*; i.e., trust that others are committed to work toward the team goals as well as trust in team members' technical competence and their capacity to contribute to success. A second factor is the *richness of personal interaction* in terms of its frequency and intimacy (e.g., face-to-face communication permits more interaction and implicit sharing of information than remote communication). A third factor is *Information redundancy*, which refers to the extent to which the organization supports sharing of more information than is minimally necessary. This factor affects team members' trust in the team orientation and contributes to creativity by allowing more organizational knowledge to be considered by more members.

Madhavan and Grover describe a number of implications of their theory. These include the need to:

- Seed teams with appropriate A and T shaped skills and mental models.
- Develop programs to generate these skills and models.
- Establish as part of corporate knowledge the best practices for NPD.
- Determine whether electronic communications for distributing information are necessarily the best for distributed teams.
- Train team members on knowledge management in distributed cognition.
- Provide intermediate team goals designed to establish appropriate trust dimensions

With respect to the theory of Common Intent, there are several parallels between NPD teams and military command teams: multi-disciplinary, large scale, ill-defined problems, and need for creativity. This is especially so, if the military "product" can be seen as mission planning and implementation. The concepts of embedded and embodied knowledge present a different perspective on the nature of shared knowledge within an organization. The authors add several implications. Tacit knowledge, which contributes to embedded knowledge, can be considered as an organizational phenomenon as well as an individual and group one. Synergistic interaction among individuals can produce a group product superior to the sum of individual contributions, i.e., the organization will act as though it has greater knowledge than that of all its members. Too strongly shared mental models may be counterproductive. Diversity within a group needs to be managed and that management of the skill and knowledge profiles of individual team members can contribute to this.

Madhavan and Grover's (1998) framework is provocative and it could further the development of aspects of the theory of Common Intent. In particular, it suggests that there is a distinction between shared intent (embedded knowledge) and using it synergistically to promote better organizational performance (embodied knowledge). We were, however, unable to obtain any other articles that provided either theoretical development or empirical support for Madhavan and Grover's proposals. As it stands, Madhavan and Grover have provided little in the way of detailed formalization of concepts such as "A" and "T" skills although these concepts seem as relevant to bringing together the diverse specialties in a command team, be it naval or army, as in new product teams. Neither have they provided empirical results to confirm or disconfirm their framework. Consequently, further research is needed to test their specific proposals and to identify how the concepts of embedded and embodied knowledge relate to sharing intent in the military domain.

## 5.5 Research Implications

The material reviewed in this section suggests·

- A framework for what information needs to be explicitly communicated by a commander; i.e., the command concepts (Builder et al., 1999) that govern the planning and conduct of an operation.
- A tripartite structure for information to be encompassed by team mental models and the kinds of information that need to be implicitly shared for each mission.
- Every point explicitly communicated will necessitate some implicit shared intent.
- There is some evidence that as mental models develop they become more "compiled" and therefore less accessible conscious thought. This may imply that long standing mental models are more enduring and resistant to change.
- Distinguish between Exogenous (team membership) and Endogenous (organizational) factors.

In terms of the theory of Common Intent, the material reviewed in this section is seen as primarily addressing control issues (methods of implementation) rather than command issues (goals and desired end-states)

# 6. Common Intent: Related Concepts

The review of the literature revealed several lines of research that seemed to converge on the concept of Common Intent. That is, these lines of research describe theoretical concepts that are similar to, or consistent with, Pigeau and McCann's theory of Common Intent. Such related concepts are critical to validating and elaborating that theory and so we discuss them first.

This section reviews:

- A theory of *command concepts*, which is an analysis of explicit command intent as it applies to military organizations.
- Concepts of team *mental models* related to team performance
- The concept of shared *tacit knowledge*.
- The concept of *common ground*, which provides an account of shared knowledge representations and processes that serve as the basis for comprehending communications between two people.

## 6.1 Theory of Command Concepts

Builder, Bankes, and Nordin (1999) observed that military commanders and decision makers are increasingly confronted with an overload of information and few tools that help them effectively use it. The problem, they argued, is that the emphasis on technological approaches to C2 are based on the faulty assumption that effective C2 depends on acquiring, sorting, and transmitting information.

Instead, Builder et al. argued that, although technological support for organizing and processing information are important, the real key to effective C2 lies in understanding and supporting the cognitive processes of commanders at all levels: from the theatre commander to the infantry squad. That is, the quality of commanders' ideas and the sharing of their visions about how individuals and units should contribute to accomplishing specified goals play the key roles. Thus, effective C2 relies on a concept of impending operations that guides subsequent command decisions by both the overall commander and all subordinate commanders as they prepare, promulgate, and implement their own concept of operations within their limit of responsibility.

The overall commander and staff develop a broad concept of an operation, which is a formal description of the operation and plan for achieving operation objectives, that then guides all subordinate commanders. Thus, Builder et al. consider the sharing of the concept of the operation to be critical as well as its formulation. By reference to a shared concept, subordinate commanders can respond to unfolding events in a manner consistent with the overall commander's vision Sharing the concept also enables subordinate commanders to select and channel upward only information that relates to the continuing effectiveness of the concept. This results in more effective C2. Builder et al view the ideal C2 system as transmitting only information that will help commanders at any given level confirm or alter the command concept.

Members of the military commonly refer to the notion of a commander's "vision" for a military operation (Builder et al., 1999; Shattuck, 1996). A vision encompasses the expectations of possible and desirable outcomes. It lays out a plan for an operation with contingencies and indicators used to monitor whether the operation proceeds as anticipated. Building on this idea, Builder et al. define a command concept as "a vision of a prospective military operation that informs the making of command decisions during that operation." (An operation is taken to imply planning, preparation and implementation). The commander's vision may be expressed in the concept of operations to guide subordinates.

In their conceptualization, when analyzing a historical battle, an ideal command concept is a "hypothetical statement of the commander's intent that should have been, under the doctrine, training, and common knowledge of the time, clearly sufficient for subordinate commanders to successfully execute the responsibilities they were actually called on to fulfill during battle, without exchanging additional information with their superior commander."[12] Builder et al. summarize this definition as the answer to the question, "*What would the commander have had to tell his subordinates before the battle in order to have made their subsequent actions conform to his concept?*" This suggests decisions concerning what sum of knowledge is required to conform to the commander's intent what has to be explicitly communicated and when, and what can be left implicit.

The function of the command concept is to guide decision making of others during an operation. As such, the command concept must be shared for two reasons. First, it enables all parts of a commander's distributed forces to work in a coordinated fashion toward a single purpose, even though those parts may operate with little explicit coordination. Second, it bounds the information needs of the commander and enables subordinate commanders to pass along only that information concerned with the command concept.[13] This reduces communication demands and makes C2 more effective.

Builder et al.'s (1999) analysis points out a key consideration for C2, that the *sharing* of intent must be examined in the context of the *content* of intent. The presumption that members of a military organization will possess accurate and useful concepts that need only be shared effectively with others to ensure effective performance is not warranted, given history's lessons. Thus possession of common intent may improve mission related processes but will not ensure a successful mission outcome.

Builder et al.'s theory of *command concepts* and the theory of Common Intent are similar in the premise that effective planning and execution of operations by subordinates must be based on a shared understanding of command intent at every level of the organization. This shared understanding of command intent is presumed to enable subordinates to act in a coordinated fashion toward accomplishment of overall mission goals and to select and communicate relevant information vertically and laterally.

The theories differ, however, in their focus. The theory of Common Intent casts a much wider net than Builder et al. to deal with the broad structure of intent, implicit and explicit, on which the implementation of any explicit statement of command intent depends, as well as the processes by which intent is shared. The theory of command concepts primarily addresses the requirements of the explicit content of a commander's intent. That is, Builder et al. specify the kinds of information that should be conveyed by the commander at any given level to subordinates and that subordinates should use this to guide their actions, including the selection of the information they feedback to the commander. Their theory expands on the necessary content of explicit intent by providing a framework in which to evaluate what has to be explicitly communicated in order to allow subordinates to act in accord with the higher commander's intent. The command concepts, however, do not provide much insight into the shared meaning or understanding needed to establish shared implicit intent.

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[12] Note our underlined emphasis of the implicit elements in this conceptualization.

[13] Builder et al (1999) indicate a number of questions that a subordinate could ask to evaluate whether certain information should be passed up to higher command. Are things going as planned (envisioned)? If not, what is broken and needs fixing? Why and where are things going wrong? Is the command concept wrong or does it simply need adjustment?

Builder et al. do not address in detail the question of how a commander can best communicate his or her concept and they avoid direct discussion of much of what Pigeau and McCann consider as implicit intent, such as the military doctrine of the day. In this respect, the two theories may be considered complementary. The *theory of command concepts* can illuminate what kinds of explicit information commanders at all levels will need and must exchange for a successful operation. The theory of Common Intent can illuminate the ways that command concepts are promulgated, the relationship between what must be made explicit and what left implicit and the factors that will affect to what extent shared understanding is achieved by commanders and decision makers. Furthermore, in practice, for any given mission, the theory of Common Intent must deal with the information content (explicit or implicit) required for any given mission.

## 6.2 Shared Mental Models

The research on team mental models highlights three core categories of knowledge that could extend to shared intent:

- **Task or domain knowledge**: What is to be done, and how.
- **Team or organization knowledge**: Members, roles, and how to work together.
- **Resource or physical environment knowledge**: Systems, resources, and how to use them to accomplish tasks.

These categories can be used to structure research on the body of implicit and explicitly shared intent required for the combination of any given mission and any given command team. Thus, to maximize its effectiveness, any command team information should maximize its common intent with respect to each category.

Each category is relevant to shared intent but their interactions even more so. The research makes clear, for example, that shared knowledge of the team is needed for effective teamwork, which is, in turn, needed for effective team performance. Thus, shared understanding in each area supports overall team functioning like the legs of a stool; if one is broken, the entire stool falls over.

For teams to be effective in solving C2 problems, they must share the same perceptions of goals and contingencies (Basar & Cruz, 1984; Builder et al., 1999; Heffner, 1997; Mohammed, 1996). Moreover, to work effectively toward a clear set of goals, team members should adopt the same mental model of the decision making environment, including tasks, problems, assumptions, categories, and issues (Mohammed, 1996). A common premise of research examining team functioning is that having a shared mental model aids the team in a number of ways (Entin, Entin, MacMillan, & Serfaty, 1993; Kraiger & Menzel, 1997; Shattuck, 1996, Rouse et al. 1992):

- Provides common goals.
- Reduces planning time.

- Generates similar explanations for observed phenomena.
- Defines working relationships and roles.
- Facilitates appropriate and effective communication, with less overt communication.
- Makes teams more flexible or adaptive to changing situations and resilient to stress..
- Facilitates coordination: team members more accurate in predicting others behaviour..
- Improves morale and mutual trust.

Thus, shared mental models are thought to keep team members "on the same page," and help them work in ways that support each other and the team as a whole.[14]

A good deal of evidence supports this view. This evidence comes from research that has typically examined mental models within small groups, although a few studies have specifically addressed mental models in large organizations (e.g., Mohammed, 1996). All studies are faced with the challenge of assembling a team to study that represents the reality of team social and cognitive dynamics. Various experimental and survey approaches include:

- Students with little team or occupational experience of the task setting.
- Groups drawn from the same occupational organization (e.g. naval personnel) brought together temporarily to work on a simulated naval task.
- Teams which interact once, or over a series of sessions.
- Surveys of pre-existing teams about work in their normal context of operations.

Sharing of mental models seems to enhance teamwork in several ways. First, shared mental models enhance communication among team members. Rentach et al. (1998), for example, examined the role of shared mental models (they referred to them as team schemas[15]) in team interaction and performance on a simulated rescue task. Two-person teams of undergraduates were brought together and each member had his or her mental model of the task and team assessed by questionnaire. Rentach et al. (1998) found that the accuracy of team members' mental models (i.e., the extent to which they understood the task and accurately predicted the other members' models of the team) predicted team performance on the task. The depth of communication in terms of the information exchanged between team members also predicted performance, such that teams that communicated more conceptual information about the task were better than those who communicated at a more superficial level. A limitation of this study, however, is that no direct links were observed between shared team models and communication depth. No connection was found between several individual differences such as inter-personal trust or experience working with teams and the similarity of the team members' mental models about how teams work. However previous experience in teams did correlate with increased exchange of information.

Sperry (1995) examined mental models, team communication patterns and the decision making performance of twelve U.S. Navy Command Information Center (CIC) teams for the AEGIS class cruiser. These teams consisted of the Tactical Action Officer (TAO) and four subordinate team members. Sperry predicted that shared team mental models would allow team members to anticipate what other team members will do and what information they will need. *Implicit communications* were defined as the transfer of information to another team member without any request for that information. These reveal the presence of shared mental models. Sperry considered a wide range of hypotheses concerning the relationship among variables such as team mental models (as assessed by a pre-mission questionnaire), team performance, frequency of implicit communications, anticipation of others needs, individual differences in operational experience, perceived workload and confidence in other team members.

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[14] The role of shared mental models likely becomes more prominent as teams progress through various developmental stages (see Tuckman & Jensen, 1977)

[15] The terms schema and mental model refer to distinct kinds of mental representations (see Matthews et al., 1999) but researchers do not always use the terms appropriately A schema refers to a long-standing conceptual representation of a general class of systems or events, whereas a mental model represents a specific system or event. Thus, mental models can be subsumed in a schema but a schema is more abstract than a mental model

Sperry had each team perform two 2-hour scenarios in a simulated CIC managing an air war as enemy contacts were detected, identified and engaged. The number of aircraft contacts a team had to cope with was varied to represent low stress or high stress. During the scenarios, Sperry recorded the volume and pattern of communications among team members. Following each scenario, expert raters assessed team performance. Sperry's results were as follows.

- *Teamwork:* Teams with superior performance received better observer ratings in terms of commitment to working together, use of standard communication procedures, feedback among the team (giving or seeking information), back-up (assisting other team members), and for timely integration of their activities. Superior teams also exhibited fewer communication-related errors, and procedural or decision errors. The TAOs or team leaders on superior teams provided more tactical direction to their teams, more assistance to team members, and had more information passed to them from their teams who better anticipated their TAOs information needs.
- *Communications*: As might be expected, all teams communicated more under higher stress (i.e., more aircraft contacts to deal with) with higher rates of internally and externally requested information. Superior teams had more communications per scenario, most of which were accounted for by the team leader or TAO. TAOs on superior teams communicated more to the outside world. Subordinates on superior teams requested less information (perhaps because their TAOs were better at anticipating the information needs of their team members). Superior teams had higher transfer ratios from subordinates to TAOs (i.e., sent more information than requested, which constitutes more implicit communications) and had higher acknowledgement rates.
- *Team confidence:* No difference was found among teams in terms of the confidence expressed about other subordinate team members, but there was greater confidence in expressed in the TAOs for superior teams by their team members.
- *Workload:* Subordinates on superior teams rated workload higher than did subordinates on inferior teams.
- *Background:* There were no significant differences among team members or TAOs.

Sperry's prediction that teams with superior performance would use more implicit communication (implying mutual mental models of team and task knowledge) was partly supported by findings that superior teams sent more unrequested information but also made more requests. The latter finding contradicts Sperry's claim that a shared mental model reduces the need for explicit communication. A concern with the task used by Sperry (and others) is that it may be largely routine and procedure driven with team decisions turning less on the nature of the mission than on the steps in the procedure.[16]

The use of implicit communication illustrates another benefit of shared mental models, that they help team members to predict the needs and actions of other members, which allows them to more effectively support those other team members Rouse et al. (1992) observed that domains such as naval C2 are fast tempo and require coordination of team members with different roles. When individual team members fail to act appropriately and within time constraints, the team as a whole can fail. Thus, teams that are trained to instill mental models that provide better descriptions of what a system is for, what it looks like, how the system works, what it is currently doing, and how the system will likely behave, can be expected to perform better, particularly in terms of communication and coordination.

Rouse et al. (1992) study observed expert and novice U.S. Navy CIC teams during a two-hour exercise in a training simulator. They documented errors and problems encountered by teams and analyzed their causes and antecedents to determine whether shared understandings and expectations played a role in mitigating difficulties. They also analyzed NASA (National Aeronautical Science Administration) aircraft incident data (some ten thousand citations). The primary proposition in their research was that enhanced and compatible team mental models would improve measures of team performance, particularly in terms of communication and coordination.

Based on these analyses, Rouse et al. (1992) concluded that communication problems dominated error occurrence with 81% of team performance deficiencies associated with a lack of, or inappropriate, explanations or expectations of the team and task on the part of team members (see also Matthews, Webb, & Bryant, 1999). Among the common team deficiencies were failure to communicate when expected (usually too late) or with needed information, failure to understand communication, lack of follow-on communications, and communicating too much information. Rouse et al. concluded that the teams did not know what to expect of others and that these deficiencies could have been remedied by a greater sharing of mental models among team members. However, the tasks used by both Sperry and by Rouse et al. seem to be characterized more by the effective use of routine procedures rather than decisions based on a common understanding the overall goals of the mission.

The research cited so far (Rouse et al., 1992; Sperry, 1995; De Vries, 1999) not only suggests that shared team mental models facilitate teamwork processes, such as communication and coordination, they also seem to lead to better overall team performance. In part, this reflects the beneficial effects of teamwork itself. Others have demonstrated empirical links between teamwork processes and team decision making and problem solving (Brannick et al., 1995; Salas, Cannon-Bowers, & Johnston, 1997). Beyond this, however, there may be other beneficial effects of team mental models on team performance.

Shared mental models also foster group trust and cohesion In an interesting study of African Pygmy culture, De Vries (1999) found that Pygmy villages develop shared norms and practices that serve as a governing organization. Village norms are internalized from an early age. Such norms are like shared mental models in that norms and beliefs represent the village organization and create expectations about roles and behavior.[17] Chief among these values is cooperation (a team process), as the Pygmy society stresses sharing and mutual responsibility. De Vries (1999) noted that members of the village share a strong sense of responsibility toward one another and protect and support each other. There is a shared conviction that they can rely on one another. Conflicts between villagers are resolved by the whole village through a conciliatory process. Mutual understanding facilitates open dialogue and exchange of ideas, which further contribute to the cohesion of the village.

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[16] Research footnote A key element for the theory of Common Intent is the adequacy of the reaction of teams to unforeseen events and the degree to which they can coordinate their response based on a common understanding of the situation and anticipation of the reaction of others Largely procedural tasks such as the one used by Sperry may not challenge that aspect A more appropriate experimental tasks are likely those in which there is a greater degree of unpredictability and where reference to mission goals rather than prosecution of standard procedures is required for example for an infantry section - attack or patrol rather than fixed site defense

Having a shared mental model may increase team members' satisfaction with, and commitment to, team decisions. Mohammed (1996) examined decision making by college students in a group decision making task. The participants were given roles as representatives of different stores in a commercial market and asked to resolve several issues pertaining to the operation of the market. Participants were surveyed to assess the degree to which they shared common mental models of the task prior to group interaction. Following group interaction, Mohammed assessed each individual's satisfaction with the process and the decisions reached. Although the extent of shared mental models did not predict process satisfaction for all decisions, it did show some positive effect. Moreover, there was a positive relation between satisfaction with both the process and outcomes and the success of teams in reaching a decision within the time allotted. Thus, shared mental models seem to reduce negative feelings that can be created by team interaction and facilitate solving of the problems at hand.

Hoopes and Postrel (1999) have similarly documented that shared mental models can enhance the process of team decision making. They hypothesized that team mental models (or shared frames, as they termed them) help product development teams be successful. In support of this hypothesis, they noted that the software development industry has largely reached a consensus that the capabilities of superior firms are characterized by successful integration across diverse functional and disciplinary specialties. Moreover, research has revealed a correlation between more extensive team integrating mechanisms and better product development performance. To further explore this relationship, Hoopes and Postrel (1999) directly assessed the level of shared mental models and knowledge within product development teams within a large software firm. In a review of 217 projects, they found that the absence of shared knowledge had a large negative effect on team performance. Teams that shared little common understanding of the development process were more prone to "glitches," catastrophic errors that occurred despite the presence of sufficient knowledge within the organization. These glitches represented failures of the team to adequately communicate and coordinate, so that knowledge needed by certain members was not passed along. Typically, low shared mental model teams failed to detect and correct developing glitches. Overall, Hoopes and Postrel's (1999) study suggests that a shared mental model is needed by team members to form a single, coherent *team* process for solving problems. When a team lacks that shared model, information can be lost to the problem solving effort, resulting in failure.

This suggests that shared purpose and desired end state are not enough to avoid glitches. Team members must understand enough about (and communicate to other specialties) the significance of their own specialist knowledge and the consequences of their own actions with respect to the goals of other team members with other specialties. For example, the artillery specialist in an army combat team must know enough about the infantry to be able to select and communicate relevant artillery information that may be of significance to the infantry group with whom he works (and vice versa). Similarly, the sonar specialist in a naval ship operations team must know what information to select and communicate to the surface radar specialist.

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[17] Conceptualizing this study in terms of shared mental models provides too limited a view of the kinds of social interactions involved The study, however, is a good example of sharing intent

Individual and shared mental models have been studied extensively for at least two decades and numerous studies have validated these concepts. Much of this research, however, has been conducted in laboratory settings, using artificial tasks and university undergraduates as participants. This creates two problems when attempting to generalize research findings to real world domains such as military C2. First, laboratory studies tend to focus on performance of specific experimental tasks and, hence, limit the scope of the mental models participants create and employ. Rentach et al. (1998), for example, examined shared mental models of two-person teams performing a simulated rescue task. Because the participants were undergraduates, they had no context in which to represent the task and could have created only rudimentary mental models. Perhaps due to the inherent complexity of even highly focused mental models and the practical challenges of assessing them, relatively few researchers have investigated long-term, very complex mental models in real-world settings, at least not to the same level of detail as mental models in laboratory settings.

A second problem is that most laboratory studies have employed "artificial" teams to study shared mental models; that is, groups of strangers assembled solely for the purpose of the experiment. Theorists generally argue that mental models are dynamic, evolving entities, which suggests that shared mental models will develop over time. Some studies (e.g., Rouse et al., 1992) have contrasted "expert," or pre-existing, to novice teams, specifically to identify the kinds of developmental changes that occur in team mental models through time and experience. Others (e.g., Stasser & Hinkle, 1996) examined teams of undergraduates but kept each team together for several sessions and examined the impact of providing feedback on team behaviours between each session. Greater attention to these issues could yield a better understanding of the shared intent by illuminating the growth of knowledge structures (such as the intent pyramid).

The concept of the *shared mental model* in a team context bears a number of similarities to the theory of Common Intent. Both argue that groups of individuals function more effectively as a team if they share an organized and common knowledge structure that represents the functioning of the system, the task and teams (and the team itself). The knowledge representation guides the efforts of team members and their communication among each other. A shared mental model directs team members as to what roles they are to play, what tasks they are to perform, how to coordinate within the team by predicting each others information needs and the likely behaviour of the system as whole. Moreover, that these knowledge structures will be acquired through common training and experience. Likewise, common intent conveys more than just team goals; it provides, among other things, the same kind of direction as a team mental model.

The main difference between the two concepts seems to be in the level of focus or specificity of the shared representation. As examined in empirical studies, team mental models tend to focus on relatively narrow problem or task domains, defined in procedural terms rather than mission goals Furthermore, the concept of a shared mental model has most often been applied to small group settings; only a few studies have addressed large organizations (e.g., Hoopes & Postrel, 1999; Mohammed, 1996; De Vries, 1999). However, although the concept of Common Intent has been developed to deal with large multi-function organizations and highly complex problem domains. in practice this achieved by a hierarchy of small command teams each working within a delimited problem range. This distinction seems important to the choice of problem to be studied for the theory of Common Intent. In their theory of Common Intent, Pigeau and McCann focus on effective command related decisions (what to do when the plan goes wrong or what information to provide to the commander for him or her to know what is going on) rather than the effective completion of largely routine procedures (such as making aircraft contact reports or firing a weapon). This focus should be reflected in the design of any study of intent.

Overall, one link between shared intent and effective C2 is through enhanced teamwork. That is, shared knowledge of task, team, and resources aids team members in performing their individual responsibilities, supporting teammates, and distributing resources most effectively. When teams can do these things, they will perform better as a unit and may receive other benefits such as increased trust and team satisfaction. However, discussion of tasks in the literature on team mental models seems to have more to do with shared understanding of procedures and team roles and information needs than of higher order mission goals. The theory of Common Intent addresses both goals and procedures.

## 6.3 Sharing Tacit Knowledge

The relation of TK to common intent can be seen at the implicit levels of the intent pyramid (personal, military, cultural). Some knowledge contained at these levels likely pertains to practical procedures for performing one's role within the organization. This would include knowledge of one's roles, others' roles, how to work with others, and so on. Thus, there is an overlap between the TK that can be assessed among members of the military organization and the contents of their intent pyramids.

The theory of Common Intent encompasses more than implicit, procedural, domain related knowledge, though assumptions about the existence of tacit practical "know-how" among team participants must guide communication and implementation of common intent. The validation of TK as predictor of success in several different domains, provides considerable support for the importance of implicit knowledge to problem solving and effective interaction within groups. However, TK is primarily concerned with the knowledge possessed and used by individuals rather than groups and has little to say about the process of acquisition or sharing.

By definition, TK pertains to practical knowledge of how to succeed in one's job, rather than to a broad knowledge base consisting of attitudes, values, and beliefs. Thus, studies of TK provide little direct evidence in support of the theory of Common Intent especially if the focus is to be primarily on command intent (i.e., purpose) rather than its implementation. Nevertheless, the research of Sternberg, Horvath, and colleagues suggests a way to operationalize and study the content of people's intent pyramids. The methodology underlying the TK survey may provide an important means of determining the required content of common intent in specific cases. TK surveys provide a model for developing broader knowledge surveys that can be used to assess explicit and implicit intent. Rather than focusing just on procedural knowledge (if-then conditionals) intent knowledge surveys could be developed to assess command concepts, domain knowledge, team knowledge, and so on.

## 6.4 Common Ground

Communication is an area in which the idea of shared knowledge representations has been especially influential A key issue in the study of communication has been how people can convey ideas through a serial, limited channel such as speech or written text. Clark and his colleagues (e.g., Brennan & Clark, 1996; Clark & Brennan, 1991; Isaacs & Clark, 1987; Schober & Clark, 1989) have developed the concept of *common ground* to address this issue. They argue that people do not have to explicitly express the majority of information underlying a message. Instead, they rely on the vast knowledge of the addressee to allow comprehension.

Common ground consists of the mutual knowledge, beliefs, and assumptions held by people (Clark, 1985, cited in Isaacs & Clark, 1987; Clark & Brennan, 1991). This mutual knowledge defines concepts and ideas that can be referred to with simple messages. As such, the concept of common ground is not radically different from the concepts of mental models and mental schemata. All of the research examining common ground, however, has addressed its role in communication. Furthermore, Clark's formulation of common ground possesses a number of subtle distinctions, particularly in terms of generality, that set common ground apart from theories of mental models.

To coordinate in a conversation[18], which is a basic means of sending and receiving information, people attempt to reach a criterion of understanding. Grounding is the collective process by which participants in a conversation try to reach a mutual belief that each party have understood the previous messages (Clark & Brennan, 1991). This means that individuals collaborate in the communication process.

Contributing to a conversation entails two phases (Clark & Brennan, 1991). The first is the *presentation phase*, in which someone utters a message. The second is the *acceptance phase*, in which another person accepts the utterance by displaying evidence that he or she believes he or she has understood. If a person does not understand the message, he or she can initiate a side sequence to request clarification. Grounding can take the form of positive feedback (acknowledgement, continued attention) or negative feedback (question, non-verbal signs of confusion) (Clark & Brennan, 1991).

Grounding is not a passive process and Schober and Clark (1989) have obtained evidence of the active collaboration involved in conversations. They examined three-person situations in which two people engaged in a conversation and a third person was an overhearer who could listen to the conversation but not contribute any input. Overhearers exhibited much worse understanding of the conversation than the participants, despite having heard the same messages. What overhearers did not have access to was the collaborative process of monitoring the addressee for understanding. When an addressee does not understand, the speaker directly responds to the addressee's request for clarification. For the overhearer, there is no collaboration; if he or she does not understand, then he or she cannot request clarification and must rely on conjecture. Moreover, part of the collaboration process is searching for a common perspective on issues. When a common perspective is reached, it is used to simplify the conversation process and make it more effective. An overhearer must accept the perspective used by the speakers and may have difficulty grasping it.

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[18] A conversation refers to any kind of communication interaction between two or more people, including face-to-face speech, telecommunication, on-line text communication, and the like

Brennan and Clark (1996) have referred to this reaching of common perspective as a *conceptual pact*. A conceptual pact is a shared conceptualization of a term or expression that can be used by people involved in a conversation. This aids communication by giving participants a customized language that can capture complex or difficult to express concepts. The conceptual pact can even be maintained over time to be used when the same people communicate again and again.

The concept of common ground was developed by Clark and colleagues through the 70s and 80s. Numerous experimental studies have been performed to validate the concept and explore the role of common ground in communication. This research has studied communication almost exclusively in laboratory settings, with undergraduate participants, and highly artificial tasks. The goals has been to uncover fundamental principles of communication rather than practical lessons pertaining to ways of enhancing communication effectiveness. Consequently, the research on common ground cannot be placed with any great clarity into an organizational context. That is, it remains largely unknown how common ground develops in, and is influenced by, the structure and practices of an organization such as the CF. There remain many topics for exploration in this area, including the impact of training on common ground, and the levels of complexity and specificity of naturally developed common ground among sub-units within an organization.

Although there remain questions, the basic findings of common ground research should generalize to any organizational context. Empirical findings concerning common ground has been extensively replicated and the research findings are solid. They indicate that people require a great deal of shared knowledge in order to communicate efficiently and effectively. Moreover, people employ a range of conversational techniques to tailor messages to addressees and solicit and provide feedback as to understanding. These processes generalize to real world communication and support the basic premises of the theory of Common Intent.

Although the concept of common ground is useful, we must look beyond just linguistic communication to more fully understand how teams and organizations function. It is also important to understand how individuals interact behaviorally. A concept similar to common ground can be applied to this issue and several researchers have advanced the idea that people rely on shared knowledge, beliefs, and assumptions to guide their behavior within a team or organization; i.e., common ground in a broader sense (e.g., Kraiger & Wenzel, 1997; Rouse, Cannon-Bowers, & Salas, 1992).

Common ground should be included as a part of implicit intent. It reflects the shared concepts, terminology, and communication protocols that people develop to communicate effectively. Military organizations are famous (or perhaps infamous) for developing their own jargon, which is often impenetrable to outsiders. The research on common ground, however, indicates that this actually goes well beyond just specialized terms and names. A military organization likely develops multiple specialized "proto-languages" containing their own words, concepts, grammatical structures, and protocols for ensuring mutual understanding.

As described in the literature, the concept of common ground is not comprehensive enough to address questions of how organization-wide communication concepts are developed and promulgated. A major aspect of shared intent will be the proto-linguistic concepts of an organization. Studying the special language use within the CF should yield insights into the common intent among its members. Consequently, the research on common ground will provide a guide to exploring specific questions of communication within the military context. Other aspects of interest concern the degree to which different methods of communication facilitate or inhibit the use of common ground by participants

For example, an ongoing debate within naval C2 circles concerns the placement of members of a command team within an operations room. The debate focuses on the relative merits of grouping team members around a common plot to permit face-to-face contact during operations versus an in line arrangement of computer consoles that limits contact to digital exchanges via the screen or auditory contact over headsets. Those that have experienced both favour the common plot largely for the reasons outlined here, namely that direct face to face interaction improves communication.

## 6.5 Research Implications

The theory of Common Intent proposes that effective C2 rests on establishing common intent among participating individuals and groups and transforming that common intent into coordinated action. Within common intent there are two components: explicitly communicated instructions and implicit knowledge on which the effective implementation of the explicitly communicated instructions depends. Furthermore, explicit instructions are assumed to include all directly communicated information (not just the commander's statement of intent as in the formal military definition). Common intent concerns all knowledge (expectations, understanding, beliefs, values, procedures, insights about other team members or groups), whatever its source and whenever acquired, that is relevant to successful mission completion. Thus, knowledge previously acquired through explicit communication during early socialization such as recruit training may subsequently be assumed and left implied during the communication of the directives for a given mission. The literature reviewed in this section is seen as supporting and, in some cases, expanding on these general concepts.

There are some methodological issues concerning the results, however:

- The research on decision making and group processes in relatively small multi-specialty teams of about 2-10 persons in other domains is seen as appropriate to the military command context. To focus any research it will be necessary to characterize team sizes and diversity in terms of the organizational level(s) of interest in the military and for different phases of the mission e.g. planning and implementation.
- The procedural nature of team tasks studied in some of the literature may not be appropriate for studying the more goal related aspects of command intent. For example, some simulations focus on routine identification and engagement of aircraft rather than the ability of the team to react to unforeseen circumstances by adjusting previously established plans or procedures in light of their common understanding of mission goals. This point relates to the need discussed in the previous section about clarifying the focus of the theory of Common Intent in terms of the why (goal) and the what (desired end-state) that the team is to achieve rather than the how (the method).
- The composition and attributes of the teams under study and the relevance to their background experience of the "mission" to be performed will be important with respect to the validity of the results for any military application. The theory of Common Intent highlights the issue of the implicit knowledge that individual members contribute to a team process, including their common understanding of explicit instructions. One may question the validity for military command applications of data based on university students working on a problem with which they have limited familiarity, in a team of short duration, the members of which have no common history.

- An inverted-U relationship between team performance in dealing with novel problems (akin to the generation of a plan or reacting to unforeseen circumstances during execution of a mission) and team diversity in terms of mental models or shared intent That is, too much or too little diversity will reduce the likelihood of a satisfactory solution being generated (see also the discussion of group processes to resolve within group conflicts arising from diversity.) Too little or too much shared intent may prove counter-productive by either failing to provide the basis for effective coordination of actions or sharing of key information, or by limiting the likelihood of generating solutions that step outside the established conventions of the group.

Despite such concerns, the research reviewed helps establish several points:

- Teams interact more effectively (make better decisions) and efficiently (need less explicit communication, show better anticipation of others needs) if they share common mental model(s).
- The components that mental models need to cover include tasks, team processes, and the context of operation in terms of other elements in the system, such as equipment and the environment. Within the task component, however, the significance of differences between goals and procedures need to be distinguished more clearly.
- Some indications are provided as to the content of the knowledge that must be shared (explicitly or implicitly) for effective command. Coverage ranges from a minimum of purpose and desired end-state to the more comprehensive catalogue of command concepts proposed by Builder et al. (1999). The means of implementation is directly or indirectly set apart as being outside the scope of command. This may be contrasted with the theory of Common Intent, which uses the term intent to cover both purpose and desired end-state.
- The literature on common ground indicates that one important aspect of common intent will be language. Methodologies should take advantage of linguistic indicators of shared mental models. Also, the process of establishing common ground should parallel development of common intent.
- Some indications are provided about relevant methods; for example, that TK surveys are an appropriate method to establish the implicit knowledge required for effective C2 and that analysis of communication patterns (such as tacit communication) reveals the presence of implicit knowledge about team processes and task needs.
- Methods for establishing the content of tacit knowledge with respect to identified areas of interest. Such an approach might be used to establish tacit knowledge in relation to common intent, or the implicit interpretation of explicit directives.
- Factors affecting combination of collective knowledge within a diverse team of specialists (such as a combat team command group, or the command team in a naval vessel) into a single product design, strategic decision, or plan.

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# 7. Acquiring Common Intent

In addition to the content and structure of intent pyramids, another major aspect of the concept of Common Intent is the sharing of intent. In this section, we explore material in the literature related to the ways in which individuals' common intent is created and modified, and how intent is shared. We attempt to identify processes that govern how intent is managed and used in C2 and to indicate areas in which further research is needed to specify a complete process account of Common Intent.

Pigeau and McCann propose four means by which individuals share intent but note that each seldom occurs in isolation.

- **Socialization**: An implicit process by which elements of an individual's, group's, or organization's values, beliefs and procedures are acquired by others.
- **Dialogue**: Acquisition of shared intent through explicit and reciprocal communication.
- **Internalization**: A process by which one unconsciously incorporates explicit information into one's implicit intent pyramid.
- **Externalization**: A process by which implicit intent is explicitly depicted through creative or expressive acts that others can observe and internalize.

We will review literature pertaining to each of these processes in turn but first examine the literature on tacit coordination. The concept of tacit coordination (Wittenbaum, Stasser, & Merry, 1996) has been proposed to be a critical aspect of teamwork. We will review literature pertaining to this concept and suggest that tacit coordination is also a process by which intent is shared.

## 7.1 Tacit Coordination

Stasser and Wittenbaum (1995, cited in Wittenbaum et al., 1996) define *tacit coordination* as the synchronization of team members' actions based on unspoken assumptions about what others in the group are likely to do. Thus, group members tacitly predict each others' behaviors and adjust their own behaviors according to the perceived demands of the collective task. Several lines of research indicate that this coordination begins even before group members begin to interact on the task (e.g., Hackman & Morris, 1975, cited in Wittenbaum et al., 1996; Gersick, 1988, cited in Wittenbaum et al., 1996).

Wittenbaum et al. (1996) developed a model of anticipatory tacit coordination. They proposed that tacit coordination requires three components (see also the discussion in earlier sections of team mental models):

- Member expectations.
- Task assessment.
- Resource allocation.

Member expectations include expectations about members' talents and actions. Each group member forms hypotheses about the domains of expertise, roles, interests, and capabilities of all other members. Based on these assumptions, each member can infer what others will do in various situations. The task assessment is a representation of what the group perceives to be the task demands and the criteria for successful completion of tasks. It also contains strategies and procedures that support successful performance. Resource allocation includes allocation of one's own resources to actions that facilitate group performance. Members must make subjective assessments of what their resources are and the utility of their potential contributions. With these three components, group members can make effective contributions to the group.

One of the ways team members collaborate is by adjusting their communication patterns. Entin, Entin, MacMillan, & Serfaty (1993) found that flight crews respond to high workload conditions by increasing their proportion of unsolicited information transfer and providing more processed rather than raw data. This had the effect of reducing communication workload so that the crew could devote more effort to decision making. Entin et al. (1993) termed this process *adaptation*, and noted that superior crews adjusted their decision and coordination strategies to maintain overall workload at an acceptable level. They argued that adaptation must be based on shared mental models of the task and team for crew members to know exactly how to adjust their behavior. Shared mental models are, in a similar fashion, the basis for sharing intent. A context-specific mental model of team and task helps individuals learn long-term roles, information needs, and so on that become established as part of the common intent among team members.

Empirical evidence supports the theory that tacit coordination relies on the existence of shared mental models which are used to generate expectations in specific contexts. Stasser and Hinkle (1996) examined the flow of information in group decision making in a naval C2 task. Participants were university undergraduates serving in seven-person teams with three levels of command. Their task was to classify radar contacts and determine the appropriate response. Stasser and Hinkle (1996) hypothesized that knowledge of information distribution within the team would help the newly formed undergraduate teams coordinate their communication. Specifically, teams in which members knew of other members' knowledge and capabilities could adapt in simple and complex situations. In this case, they would concentrate on communicating unshared information needed by others and less shared information. This is what Stasser and Hinkle (1996) found, supporting the notion that a shared team mental model is needed for tacit coordination.

Entin et al. (1996) performed an observational study to explore the process of tacit coordination. Using videotapes of two-person UH-60 helicopter crews performing simulated scenarios, they assessed the quality of teamwork with the Aircrew Coordination Evaluation (ACE) tool and the Cockpit Management Attitude Questionnaire (CMAQ). Crew performance was assessed by Aircrew Training Manual (ATM) measures and mission-specific indicators. Entin et al. (1996) monitored two sessions for each crew, one prior to the crew receiving coordination training and the other after. They computed *anticipation ratios* for each session, which were the number of information transfers divided by the number of information requests, as a measure of the extent to which each crew member anticipated the needs of the other.

The results of Entin et al.'s (1996) study indicated that the coordination training increased anticipatory behavior as measured by the anticipation ratio. In particular, in routine situations, crews exhibited more planning and problem solving and less information exchange after training. However, in crisis conditions, crews exhibited less communication about actions and tasks and more information exchange after training.

Teams with higher anticipation ratios and higher proportion of communication involving planning and problem solving exhibited better ACE scores, indicating better teamwork. Anticipation ratios and communication rates also correlated with a number of overall mission performance measures. These results suggest that crew members have mutual mental models of the other member and a shared mental model of the situation, which allow crew members to anticipate the needs of the other members without the need for explicit requests or commands.

One limitation of the research on tacit coordination is that it has focused on communication and information transfer as indicators of coordination. Both Entin et al. (1993) and Stasser and Hinkle (1996) found that teams with more extensively shared mental models communicated more un-requested information and altered the kinds of information transferred. There are, however, other aspects to coordination that have not been as extensively developed. In particular, it is likely worth considering behavioral aspects of team performance that might be affected by shared mental models. The deployment of resources (equipment, time, manpower, etc.), for example, is a critical consideration in many domains. Shared mental models presumably help team members guide their decisions about how to use distributed limited resources to best support overall team effort. Similarly, shared mental models can help members determine priorities not just in one's own set of tasks but those of others, which should improve decisions concerning when to provide help, how to sequence tasks to support others, and when to seek assistance.

Both concepts of *common ground* and *tacit coordination* support the idea that shared intent in the form of common mental models will affect the amount of explicit information provided to an addressee. Moreover, that individuals engaged in dialogue will continually seek feedback through non-verbal cues that their assumptions about what can be left implicit are in fact correct. If individuals are provided with knowledge about what information others have, then this is used to guide what information has to be exchanged, implicitly or explicitly, during a team task.

In terms of military command teams, this suggests that use of a means of communication that does not permit such feedback will result in one of two outcomes. Either there will be more explicit exchanges to resolve the uncertainty created by being unable to observe the non-verbal cues or there will be more misunderstandings as revealed by inappropriateness or lack of coordination of consequent actions, or differences in comprehension. Such assumptions are more likely to be in error when diversity among team members is greater in terms of common experience or technical specialty, especially if that implies use of a different technical vocabulary.

Tacit coordination becomes a process of adaptation by which team members modify their communication patterns, decisions, and coordination strategies (Entin et al., 1993). Adaptation helps teams manage their workload but perhaps its greatest value is in guiding individual decisions about what information needs to be communicated and in what form (raw or processed) (Entin et al., 1993; Stasser & Hinkle, 1996).

It is this latter function of guiding information exchange that suggests tacit coordination could be a mechanism for sharing intent. Presumably, as teams work together on successive occasions to complete similar tasks, then the feedback they receive (implicit or explicit), works to confirm or deny their original assumptions and to improve the accuracy of their mental models, and to bring the members of the team closer in terms of common intent. As situations change and evolve, individuals and teams must continually update their intent pyramids to reflect those changes and communicate those changes to higher command.

## 7.2 Socialization

According to Pigeau and McCann, *socialization* is one of the important processes for sharing intent and it is described as an entirely implicit process. Some researchers have argued that socialization is needed to develop shared mental models or TK (e.g., Thomas & Anderson, 1998). Socialization can be defined as the *"process of 'learning the ropes,' the process of being indoctrinated and trained,...of being taught what is important in an organization."* (Schein, 1984, cited in Guimond, 1995). It is a set of social processes by which a group or organization explicitly or implicitly instructs newcomers in the values, beliefs, attitudes, and practices of the group or organization. A large number of studies have demonstrated the role of socialization in changing the belief structures and level of commitment of newcomers in various kinds of organizations (see Guimond, 1995).

It is important to distinguish conceptually between the effects of socialization and the effects of training, even though this may be difficult in practice. Members of a group can often agree on decisions and practices without all members sharing the same underlying belief structures. This is called operational consensus and implies a level of behavioral commitment to the group but not socialization (Mohammed, 1996). In contrast, perceptual consensus occurs when group members share the same beliefs and attitudes (Mohammed, 1996). This kind of consensus is achieved through socialization as people move or are moved towards the common belief structure of an organization or group.

Another way to describe the effect of socialization is in terms of the *psychological contract* between members of the group (Thomas & Anderson, 1998). A psychological contract is an implicit, mutual understanding of mutual obligations between group members and between levels within an organization. The contract enforces an interdependency in which members tacitly accept each others' expectations. Thomas and Anderson (1998) argue that psychological contracts are dynamic and it is not just newcomers' who are affected by socialization. They noted that employers in large organizations also show changes in their psychological contracts in response to new members joining the organization. In a longitudinal study of socialization within the British Army, Thomas and Anderson (1998) collected measures of attitudes relevant to the psychological contract (see Table 7.1) and a measure of socialization knowledge or understanding of the socialization environment, the Thomas and Anderson Socialization Questionnaire (TASQ).

| **Dimensions of a Psychological Contract** |
|---|
| Career prospects |
| Job security |
| Job satisfaction |
| Social/leisure aspects |
| Pay |
| Effects on family |
| Accommodation |

**Figure 7.1 - Seven Dimensions of a Psychological Contract in an Organizational Context**

Thomas and Anderson (1998) found that new recruits changed their perception of their employer / employee relationship with the Army rapidly and in most dimensions. Over the course of eight weeks, the recruits' psychological contracts changed to be more similar to those of experienced soldiers.

Recruits also gained more socialization knowledge over time, which further influenced their perceptions of the Army, with a tendency for their perception of the obligations of the Army as employer to increase and of themselves as the employee to decrease.

Socialization can occur in any context; family, school, peer group, and occupational setting (Gecas, 1990). It is the process by which a social unit transmits values, beliefs, attitudes, and practices to new members and reinforces them to existing members (Guimond, 1995).

Guimond describes socialization as occurring in two broad phases.

- The first is an *encounter phase* in which a newcomer perceives what an organization is like; i.e. its practices and, to varying extents, its attitudes, beliefs, and values. During the encounter phase, the newcomer realizes that there are differences between his or her own beliefs and expectations and those of the organization.
- The second phase is *metamorphosis*, during which the newcomer accepts or internalizes the value structure and behavioral practices of the organization. The metamorphosis phase can be seen as a process of reducing the discrepancy between the self and the organization.

The alternatives to accepting the group belief system are to reject the group or to act according to the group's behavioral norms but tolerate the differences between one's own beliefs and those of the group

Guimond gathered evidence based on military cadets both enrolled in and undergoing training at the RMC and similar cadets undergoing training at RMC but enrolled at civilian universities. Cadets living at RMC showed a negative change in commitment and acceptance of the military ethos from the first to second year of training, whereas cadets at civilian universities did not. This suggests that those cadets with the greatest exposure to the military culture reacted negatively at the beginning of training, presumably in response to the discrepancy between their initial expectations and the realities of military culture. Cadets living at RMC, however, ultimately exhibited much greater acceptance of military ethos after four years of training than they had initially and higher acceptance than did cadets enrolled at civilian universities. This supports the metamorphosis phase; cadets at RMC have little opportunity, short of resignation, to avoid the military culture, leading to greater acceptance.

Socialization is often an explicit process in which organizations intentionally perform a series of events to either undo old values or teach new ones. Thus, these events can serve to facilitate both the encounter and metamorphosis phases. Organizational orientation and training programs often serve a socialization function. Programs that foster perceptions of interdependency and cooperation also promote acceptance of organizational values and practices (Johnson & Johnson, 1989).

The use of socialization strategies calls into question Pigeau and McCann's characterization of socialization as a process of implicit transmission of beliefs and implicit incorporation by individuals As it is described in the literature, socialization may not differ much from Pigeau and McCann's concept of internalization, which involves implicit acceptance of beliefs in response to explicit communication by the organization.

Socialization is generally viewed as a positive process with benefits for both organization and individual. Certainly organizations have a stake in promoting acceptance of the organizational culture, as this is associated with better work-group performance, job satisfaction, and control of organization members (Bollar, 1996; Mael & Ashforth, 1995; Podsakoff, MacKenzie, & Ahearne, 1997).

Organizations can promote socialization in various ways. For example, organizations can structure themselves in a mechanistic (control-oriented, process-driven, and authority-based) as opposed to an organic (flexible, goal-driven, and self-managing) fashion, which tends to produce greater adjustment in newcomers (Ashforth, Saks, & Lee, 1998). Providing positive feedback about job competence can also enhance adjustment and commitment to the organization (Adkins, 1995). In fact, socialization is not necessarily easy to achieve without some form of support from the organization. Rayer (1998) argues that organizations should support socialization in a number of ways·

- Provide assistance to newcomers in adjusting to new roles from previous roles in other contexts.
- Provide assistance to newcomers in learning underlying cultural norms and demands after they adjust to new roles.
- Use formal and informal socialization methods for learning new tasks associated with new roles.
- Involve newcomers in activities and expose them to curricula that integrate the work environment.
- Employ a transitional role (e.g., internship), where appropriate, to provide relevant experience to ease the transition to a new role.

Socialization unites members of an organization and fosters shared belief structures but it can also have negative effects for the organization. Winslow (1998) examined two cases of breakdown of discipline of Canadian peacekeeping units. She argued that exaggerated loyalty and cohesion led the units to work counter to the purposes of the Army and Canadian Forces (CF). In one case, members of the Airborne Regiment Battle Group beat to death a 16 year old Somali youth. In the second case, a battle group based on one regiment engaged in incidents of misconduct involving alcohol, violence, sexual misconduct, and black marketeering. An incoming unit received information about the misconduct but did nothing.

The root of these cases, according to Winslow (1998), was the high degree of collectiveness within the units. She notes that military culture fosters loyalty to the unit through a socialization process. The regimental tradition creates unique cultures within regiments through group activities (celebrations, ceremonies, rituals), collective mental frameworks (legends, stories), and physical artifacts (symbols, insignia, objects of significance). The regimental culture supports group solidarity, teamwork, and trust. The negative effect of this, however, is that members of a regiment can develop intense loyalty to the regiment at the expense of loyalty to the larger organization and its principles. Winslow noted that in both cases of misconduct, units developed an "us-against-them" attitude, which led them to shun other units and exhibit a lack of respect for soldiers and officers outside their own unit, or to believe that certain disciplinary matters were the internal prerogative of another unit and not the business of outsiders. As a result, members of the units turned a blind eye to misconduct and protected offenders within the unit. In these cases, socialization into a regiment created a barrier to adopting the values and attitudes of the CF as a whole.

An issue related to team diversity that was not addressed in the literature reviewed concerns simultaneous membership in multiple organizations and the consequent potential for conflict between competing values. Examples might be membership of a family, a religious group, an ethnic group, a professional specialty and a military unit. A not unusual combination might result in someone already socialized in a family group with strong religious and ethnic ties subsequently being trained in a professional discipline such as engineering before or after becoming an army specialist in artillery. It may be such a combination that resulted in the Somalia incident alluded to earlier (in which a local youth was beaten by a members of a Canadian army forces unit) being reported by the physician serving as the medical officer for the unit in question.

The research reviewed suggests that a key result of socialization is the psychological contract between individuals and the organization. This concept captures the notion of *acceptance* of the beliefs, values, and procedures of the organization above and beyond their acquisition. A person who resists socialization into a group may acquire the same organizational knowledge as others but not incorporate that knowledge in his or her intent pyramid. This would result in a different kind of learning and different interaction with the group. Sharing of intent may involve a similar psychological contract that governs whether individuals accept the intent of higher commanders.

The research also revealed that socialization is most likely not strictly a process of conveying the implicit intent of an organization to newcomers. Organizations design training programs and procedures to actively promote changes in attitudes, beliefs, and practices. This suggests that socialization can use explicit means to convey the policies and procedures of the organization. There may be a reciprocal relationship between the socialization of explicit and implicit intent. By training newcomers in explicit policies, an organization creates a framework in which to transmit its implicit beliefs. By transmitting those implicit beliefs, however, the organization shifts newcomers' attitudes so as to make them more accepting of the rules and regulations of the organization.

## 7.3 Dialogue

Dialogue, in the theory of Common Intent, is the acquisition of shared intent through explicit and reciprocal communication, in the form of statements, questions and answers via a given medium. This process can be performed in many ways, including written and graphic communication as well as verbal communication by face-to-face, teleconferencing, and so on. Nevertheless, most empirical research has dealt with verbal communication. Consequently, much of our discussion will focus on verbal communication, although we will discuss some limitations of non-verbal communication.

Although dialogue is explicit, the research on common ground and shared mental models makes clear the importance of implicit knowledge. Clark and his colleagues (Brennan & Clark, 1996; Clark & Brennan, 1991; Isaacs & Clark, 1987; Schober & Clark, 1989) have demonstrated that understanding of even the simplest explicit statement is based on a wealth of implied knowledge shared between speaker and addressee. Of course, the reverse is also true; establishing a common understanding generally requires an explicit dialogue in which to share information and points of view (Finley, 1997). During dialogue, individuals share their personal knowledge and integrate it within a collective knowledge base.

Madhavan and Grover's (1998) concept of embodied knowledge also demonstrates the need for dialogue to build collective knowledge. They argued that the results of a team's efforts are determined by the extent to which the team can elicit and make explicit the tacit knowledge and perspectives of individual members. The result is a synergy that yields team performance superior to the sum of individual efforts.

Mohammed's (1996) study of team decision making supports the importance of dialogue for team performance. Her results indicated that teams working on a consensus decision problem were able to reach better and more readily achievable decisions (as perceived by team members) to the extent they were able to create a shared mental model of the problem. Mohammed characterized the teams' initial decision making process as *negotiation*, in which team members actively attempted to make sense of the problem and shared assumptions and perceptions of issues.

Finley (1997) also stressed the importance of dialogue as a process that establishes links that allow collaboration within an organization. This is especially true in organizations that support participative decision making, which requires multiple individuals to combine their knowledge. Dialogue encourages consideration of differing viewpoints and options, contributing to creative and successful team decisions.

Dialogue is especially important in military contexts because military organizations rely on a well-structured, but dispersed, chain of command. This means that remote leaders communicate through a number of formal means (Shattuck, 1996):

- Plans.
- Procedures.
- Doctrine.
- Statements of Commander's Intent.

Shattuck refers to the communication of intent as the means by which Remote Supervisors (commanders) impart their *presence* to Local Actors (subordinates). As used in the literature, the term "*presence*" seems to refer to the concept of Common Intent. The goal is to increase the probability that the Local Actors will make the same decisions (or decisions consistent with command intent) as the Remote Supervisor would make if present in the Local Actor's situation This is accomplished when subordinates or Local Actors understand the commander's intent and share a common mental model of how to work toward mission objectives. Dialogue, then, is meant to provide the Remote Supervisor with appropriate information to evaluate the Local Actor's situation and provide the Local Actor with a sufficiently (but not excessively) detailed understanding of the Remote Supervisor's objectives and concept of operations (how things, in general, should be done). Imparting presence does not entail (Shattuck, 1996):

- Providing the remote supervisor with access to the same detailed view of the local situation as that of the local actor because this would overload the supervisor with information and obscure relevant events.
- Providing detailed procedures and telling Local Actors to follow them rotely because this restricts actors' ability to respond to unanticipated situations.
- Second-guessing the performance of Local Actors.

For the Remote Supervisor to act "*as if*" he or she was in the role of the Local Actor would risk distracting the Remote Supervisor from monitoring the activities of other Local Actors under command. It would also require the Remote Supervisor to think at the level of the subordinate Local Actor rather than at the broader, higher, supervisory level. This also under-utilizes the capabilities of the Local Actor, the end result being slow, inefficient, error-prone action directed by the supervisor.

To examine the communication of intent, Shattuck (1996) conducted a field exercise with U.S. Army commanders and their staffs based on three levels of command intent: brigade, battalion, and company. Each battalion commander developed a plan for a defensive action based on the statement of intent provided by the higher, brigade commander, referencing that higher intent in their plan, as required by the U.S. Army (and others). During the simulated conduct of the plan, each subordinate company commander was confronted with two anomalous events. The first event prevented the company from accomplishing its planned objective and the second indicated that the company had accomplished its objective prematurely and was left with decision about what to do next. To study the ways company commanders' use higher intent statements (battalion or brigade) to adapt their plans and coordinate their activities, Shattuck observed how company commanders determined what to do in response to these anomalies.

In particular, Shattuck looked at the methods commanders used to promote dialogue and impart presence to subordinates in the field. These included:

- **Briefings**: A face-to-face meeting in which the senior commander explains his or her intent for the operation and subordinate commanders ask questions to clarify that intent.
- **Backbriefs**: The senior commander confirms the subordinate's understanding of his or her intent by hearing the subordinate outline how their own concept of operations will fulfill their superiors intent and by cross examining the subordinate on that concept. This may take place in the hearing of other company commanders to promote sharing of common understanding among lateral commanders.
- **Rehearsals**: Prior to beginning an operation, the senior commander assembles the subordinate commanders and staff officers to review the plan.
- **Leader's reconnaissance**: The senior and subordinate commanders join together to perform a reconnaissance of the terrain on which they will perform the mission and the senior discusses his/her vision of how the operation will unfold.
- **On-site visits**: The senior commander visits subordinate units and confirms their understanding of the operation.

Shattuck noted that in real-world operations, battalions commanders do not always have time to use all of these methods.

Shattuck observed six categories of verbalizations in the company commanders' communications when faced with the situation report revealing the anomaly. These categories indicated the information needed by company commanders to assess the situation, determine their response, and plan accordingly:

- **Need for information**: Request additional information or state need for additional information to be confident in a decision.
- **System status**: Statement concerning the status of enemy forces or friendly forces.
- **Reference to procedures**: Reference to a procedure or other information provided prior to confronting events described in the battalion commander's situation report (operations order, unit standing operating procedures, doctrine).
- **Reference to intent**: Reference to the intent of the senior commander or the commander two echelons above.
- **Course of action**: Description of an action that the company commander would take or believes other commanders would take in response to the situation report.
- **Coordination**: Description of the efforts the company commander would take to coordinate activities with other units.

It is worth noting that both communication of intent down from senior to subordinate commander and communication upward from subordinate to senior commander are supported by feedback. The senior commander needs to assess the understanding of his/her intent by subordinates and subordinates need to assess the superior commander's understanding of the local situation (Bangs, 1983). Shattuck found that, in many instances in his study, company commanders possessed sufficient understanding of the senior commander's intent but failed to adapt the plan correctly due to a number of reasons (Table 7.2) Inspection of these reasons indicates that communication of intent must also include appropriate situation and domain knowledge needed to implement a plan.

| **Failures to Adapt:** | |
|---|---|
| Situational Uncertainty. | In four episodes, protocols indicated that the company commanders had difficulty coping with the uncertainty inherent in the situation |
| Misassessment. | In four episodes, the company commanders failed to match the intent of their battalion commanders because they did not properly assess the information available to them Company commanders also failed to match the battalion commander's intent because they improperly assessed the tactical situation. |
| Rigid Adherence To Brittle Procedures: | Three company commanders did not adapt the procedures when they were confronted with an unanticipated situation. Instead, they chose to implement the procedures even though they were not designed as a response to the novel situation. |
| Faulty Perspective Of The Environment: | In seven episodes, company commanders failed to match their battalion commander's intent because they viewed their local situation from the wrong perspective. Three of these company commanders committed to multiple courses of action They failed to realize that they were part of a larger organization that could use its resources to meet the other threats In the other four episodes, company commanders chose a single, wrong course of action |
| Conflicting Information: | The company commander proposed attacks in two directions because the intent of the battalion commander conflicted with the intent of the brigade commander. The company commander failed to adapt the plan because he did not resolve the conflict between the two sources of guidance |

**Table 7.2 - Observed Failures to Adapt to Higher Command Intent (From Shattuck, 1996).**

The CF, like other military organizations, has specific procedures for communicating the commander's intent, including friendly forces paragraph, mission statement, or opening statement in the concepts of operation. Typically, commanders are taught to describe the purpose of an operation, the methods to be used (and methods not to be used), and the desired end state for the operation (Shattuck, 1996). Because military organizations define commander's intent in terms of explicit communication, there is no clear indication that a commander must communicate hard-to-articulate values, attitudes, and preferences.

As Builder et al. (1999) argue, however, a good operational plan will provide subordinate commanders with much more information than that strictly required by a statement of commander's intent They note that highly successful operations of the past were based on command concepts that specified awareness of physical, geographical, and meteorological features, intelligence on what the enemy is expected to do, indicators of the failure of, or flaws in, the command concept, contingencies, and so on Such a command concept serves as a guide to decision making and streamlines the C2 process.

## 7.4 Externalization

There are few studies of externalization as it is related to sharing intent. Winslow (1998) does note the important role of physical artifacts in building and maintaining regimental tradition. Regiments of the

Canadian Army collect objects and various forms of creative expression that represent the regiment's history and concept of itself and refer to heroic acts by individuals to serve as models of behaviour. Such artifacts can be used in ceremonies and rituals that further strengthen emotional bonds and teach newcomers the values and practices of the regiment. Other examples may include the frequently used "war stories" or practical examples employed by experienced soldiers to illustrate the points they wish to make to others.

In some cases, externalization may take the form of a particular communication strategy. In a study of communication in entrepeneurial organizations, Hill and Levenhagen (1995) proposed that the use of metaphors can play a vital role in initially communicating complex ideas and plans. They note that an entrepeneur must develop a vision for the organization then communicate it to others to gain their support. Often, this vision begins as an intuitive concept and is difficult to articulate. A metaphor is an incomplete statement of one thing in terms of another. Thus, a metaphor can relate a new concept to an established and well-understood concept. According to Hill and Levenhagen (1995), a metaphor can benefit the communication process in three ways:

- Provides helpful interpretive schemas.
- Aids people in coping with ambiguity and interpreting large amounts of data.
- Provides an effective means of articulating a mental model.

Metaphors, of course, are not sufficient in all contexts. An organization will have to move toward formal models, procedures, and doctrine to implement a plan (Hill & Levenhagen, 1995). Nevertheless, metaphors provide a glimpse of the wide range of linguistic strategies that need to be considered when examining communication.

## 7.5 Internalization

Pigeau and McCann define internalization in terms of the intentions of the organization and individual. As they describe it, internalization is a process in which an organization explicitly communicates its values, beliefs, attitudes, and practices in various ways, such that individuals implicitly acquire and accept those values, beliefs, attitudes, and practices. This view, however, does not seem to be reflected in the literature. Few articles directly address the concept of internalization in the context of organizational performance, or those that do address internalization do not make a clear distinction between it and socialization. Moreover, it is not clear why there should be any distinction between internalization of explicitly expressed information and internalization of information implicit in the observation of others' behaviour.

Much of the research relevant to internalization has been performed in the context of team mental models. As reviewed in Section 5.2, team mental models and shared knowledge are critical to effective team performance (e.g., Entin et al., 1993; Shattuck, 1996). The development of shared mental models may provide a model of the internalization process. Indeed, Mohammed (1996) proposed three stages of implicit agreement among team members that led to shared understanding:

- Consensus on important concepts and labels to be used in discussion.
- Consensus on the relationships among concepts.
- Consensus on how the concepts relate to the team tasks and how they influence the team.

The drawback of this account is that it focuses on the content of a shared mental model but does little to elucidate the mechanism of consensus used to achieve the shared mental model. Pigeau and McCann's notion of internalization addresses the process by which individuals integrate explicit intent into their intent pyramids at the implicit level.

Finley (1997) refers to the sum total of these levels of consensus as "teammind," a term that reflects a collective representation of the team tasks and the team structure. Crucial to achieving teammind or consensus is the dialogue process (Finley, 1997). Information must flow from all parts of the organization to all members for it to be incorporated in a shared mental model. Moreover, repeated exposures to the same information is likely required for individuals to learn and accept it. Finley (1997) examined the process of forming a collective mental model in a multidisciplinary team environment. She interviewed members of the New Product Development Team at a large electronics firm and analyzed their team decision making process. The data revealed that the team required extensive dialogue and collective learning opportunities to reach a common understanding of the development problem. Instances when clients worked in the team generally resulted in misunderstandings and conflict.

Internalization can be fostered by various organization structures and practices. Chief among these is an attitude of openness that promotes communication (Kraiger & Wenzel, 1997). Without communication, the values of the organization will not be promulgated. Incentives to adopt the organization culture facilitate acceptance after individuals have learned about the organization. Rewards need not be explicitly linked to acceptance but can come in the form of team trust and support for those who "fit in." Training, of course, is common method to teach individuals about an organization in such a way that positive aspects of acceptance are highlighted, making the organization attractive to newcomers (Kraiger & Wenzel, 1997)

Military culture places great emphasis on indoctrinating newcomers so that they will accept the military culture. The CF itself trains recruits in military procedures, conduct, values, and tradition. Regiments provide less formal training situations by keeping a regimental book, holding social functions, and through interpersonal mentoring and instruction (Winslow, 1998). All these techniques have the effect of communicating the organization's belief structure to recruits and providing incentives for recruits to accept it as their own.

## 7.6 Research Implications

Pigeau and McCann do not propose that the four processes they suggest for acquiring common intent are distinct or occur in isolation, and they are vague about how and when each process might actually occur. In particular, the relative roles of explicit communication and observational or implicit learning do not seem so exclusively compartmentalized as implied by the explicit and implicit components of the intent pyramid. Furthermore, the conceptualizations of socialization, internalization and externalization appear to overlap considerably and do not reflect the consensus found in the literature.

The probable exception is the process of dialogue whereby individuals exchange explicit information about intent to confirm or establish a common implicit understanding of the topic of common interest. We believe that the most rewarding research route to follow will be this area of dialogue. This should be studied in relation to the balance between what must be made explicit and what can be left implicit, depending on mission related components in the common background or mental models of team members, and the relation to the medium of communication. We think that this might be particularly fruitful if focussed on command intent issues (i.e., purpose and desired end-state) rather than all aspects of Common Intent.

One research goal should be to establish how different sources of mission-related knowledge are acquired (socialization, dialogue, internalization, or externalization), at what point, and in what forms (implicit or explicit).

The review suggests that:

- The processes of dialogue and socialization have generated the most research in the literature.
- The military (and most other very large organizations) explicitly employ socialization to facilitate the entry of newcomers.
- The main focus of many military activities appears to be on dialogue, which is used primarily during training and mission briefings.

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# 8. Factors affecting Sharing of Intent

This section addresses factors that affect sharing of intent within the theory of Common Intent and reviews literature pertaining to communication, team mental models, and other related topics.

## 8.1 Support for Communication

One factor that has been frequently examined in studies of both shared mental models and team performance is the manner and methods used for communication. This includes not only issues of the medium of communication (face-to-face, telecommunication, written, etc.), which can facilitate or limit certain kinds of information exchanges but also the psychological and social processes and organization that govern exchanges of information. The mode of communication in these senses is obviously related to the sharing of explicit intent. As we will see, however, communication relies heavily on shared knowledge, supporting the close interdependence of explicit and implicit intent.

### 8.1.1 Communication Medium

Clark and Brennan's (1991) work illustrates how important is the medium when considering communication. A study by Graetz et al. (1997) illustrates the general approach in this area. They contrasted face-to-face communication with teleconferencing and electronic chat group communication to determine their effectiveness in supporting group decision making. Electronic chat is limited compared to face-to-face and teleconference media in terms of its low bandwidth, costly utterance production, relative dearth of linguistic cues, and difficulties in coordination among participants. The face-to-face medium especially allows many verbal and non-verbal routes to sharing information that facilitates feedback and grounding.

Graetz et al. (1997) had groups of college undergraduates solve a hidden profile problem, which entailed ranking three responses to a Request for Proposals to supply an item of military equipment. Group members possessed a mixture of shared and unique information about the features offered by each bidder, which had to be compared to a checklist of desired features to determine the winner. To do this, group members had to share information to reveal the hidden profile indicating the best proposal. Groups worked in one of three communication conditions.

- The face-to-face groups sat in the same room and used laptops, which were arranged so that members could not see others' displays.
- The teleconference groups sat in separate cubicles with the same laptop displays and spoke by phone with each other.
- The electronic chat groups also sat in separate cubicles but communicated by typing messages using the computer. Electronic messages were displayed in a quad-display that presented the current message from each group member and allowed recall of previous messages.

Graetz et al. (1997) measured the bid ranks assigned by groups, their time to decide, mental workload, and impressions of the group. A content analysis was used to assess the discussion strategies employed by groups.

The results indicated that the electronic chat groups performed only half as accurately as groups in the face-to-face and teleconference conditions (which did not differ). As well, the electronic chat groups were much slower and exhibited higher workloads. All groups reaching correct solutions in all conditions used an integrative tallying approach. The electronic chat groups, however, experienced greater frustration, mental and time demands, and difficulty in coordinating information among team members. Thus, the various media did not necessarily change the decision making strategy but did provide differential support for decision making. These results demonstrate that the medium of communication can have a large impact on communication effectiveness and, indirectly, on decision making performance.[19]

### 8.1.2 Common Ground

The research on *common ground* reviewed earlier (Section 5.4) indicates that shared knowledge is a key component supporting verbal communication. Common ground provides a shared knowledge structure with which to interpret messages from others and, equally important, tailor one's own messages to be understandable by others (Clark & Brennan, 1991). This is evidenced by the finding that overhearers who do not have access to the interaction between conversation participants have difficulty understanding the conversation (Schober & Clark, 1989). Thus, when communicating, it is important to collaborate on establishing common ground. For example, people with different levels of expertise in a given topic seek cues to assess the level of expertise of their conversational partners then adjust the level at which they provide information to best suit their partners (Isaacs & Clark, 1987).

The literature suggests that an important factor for sharing intent is the degree to which individuals share common ground. In the context of the theory of Common Intent, common ground can be viewed as a portion of implicit intent. Shared, implicit knowledge determines the effectiveness of explicit communication.

Also important are constraints on the effective use of common ground. Clark and Brennan (1991) observed that people's grounding (the process of establishing common ground) changes with their purposes, content of conversation, and medium of communication. That is, people must rely on different techniques in different situations. Table 8.1 contains various levels of constraints on grounding associated with the communication medium. Different media possess features consistent with different configurations of these constraints, as shown in Table 8.2. Face-to-face communication, for example, possesses many features conducive to establishing common ground. In contrast, electronic mail possesses fewer and is a less effective medium because it is harder to achieve common ground (Clark & Brennan, 1991).

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[19] Graetz et al (1997) did not find any differences between face-to-face and teleconference conditions, indicating that different media do not always produce different effects on team performance The impact of media will depend on the specific context in which they are examined

| Constraint: | Definition |
|---|---|
| Co-presence: | A and B share the same physical environment |
| Visibility: | A and B are visible to each other |
| Audibility | A and B communicate by speaking |
| Co-temporality: | B receives at roughly same time as A produces |
| Simultaneity: | A and B can send and receive at once and simultaneously |
| Sequentiality: | A's and B's turns cannot get out of sequence |
| Reviewability. | B can review A's messages |
| Revisability: | A can revise messages for B |

**Table 8.1 - Classes of Constraints on Grounding** (Adapted from Clark & Brennan, 1991)

| Medium | Constraints |
|---|---|
| Face-to-Face: | Co-presence, visibility, audibility, co-temporality, simultaneity, sequentiality |
| Telephone: | Audibility, co-temporality, simultaneity, sequentiality |
| Video Teleconferencing: | Visibility, audibility, co-temporality, simultaneity, sequentiality |
| Terminal Teleconferencing: | Co-temporality, simultaneity, reviewability |
| Answering Machine: | Audibility, reviewability |
| Electronic Mail | Reviewability, revisability |
| Letters | Reviewability, revisability |

**Table 8.2- Examples of Seven Media and Their Associated Constraints** (Adapted from Clark & Brennan, 1991)

In addition to differing sets of constraints, different media will have different costs associated with establishing common ground (Clark & Brennan, 1991). The kinds of costs, listed below, will partially determine people's success in achieving common ground and, hence, effective communication:

- **Formulation costs**: Time and effort of formulating and reformulating utterances.
- **Production costs**: Act of producing utterance has cost that varies from medium to medium.
- **Reception costs**: Costs in time and effort in receiving utterance; depends on medium.
- **Understanding costs**: Effort to understand depends on content, quality of context.
- **Start-up costs**: Cost of getting B initially to notice that A has uttered something and to accept that he/she has been addressed; depends on medium.
- **Delay costs**: Delaying utterance incurs costs, depending on medium (time, effort).
- **Asynchrony costs**: Degree of precision in timing utterances incurs costs; requirement for synchronicity determines costs.
- **Speaker change costs**: Cost of changing speaker varies from medium to medium.
- **Display costs**: Cost of monitoring characteristics of others to get cues to understanding.
- **Fault costs**: Costs in time, effort, etc. of errors in understanding; how sure do you have to be that utterance is correctly sent and correctly received.
- **Repair costs**: Cost of correcting a mistake.

### 8.1.3 Organizational Structure and Policies

An organization can facilitate or inhibit communication between organization members. Thus, another important factor is the structure of the organization and, in particular, the extent to which it supports the sharing of information, knowledge, beliefs, and values. Because shared team mental models seem to be important for effective communication (e.g., Finley, 1997; Shattuck, 1996; Wittenbaum et al., 1996), an organization should be structured to support acquisition of shared mental models by reducing barriers to lateral and vertical communication. Some means to accomplish this have been made by Senge (1990) and others, and include:

- Institutionalizing *reflection* by bringing together individuals at various levels to review and expand decision making procedures.
- Employing tools for mapping mental models, such as system analysis or simulation software designed to expose assumptions about organizational issues.
- Balancing inquiry and advocacy by instructing commanders to support questioning from below and provide feedback concerning subordinates' understanding
- Encouraging and providing the means for lateral communication among subordinates.

The studies of Graetz et al. (1997) and of Stasser and Hinkle (1996) on the tacit coordination of team communication based on knowledge of information distribution among the team demonstrate the importance of communication media and patterns to successful performance of small teams. Practices such as face-to-face communication and transferring unshared information to appropriate recipients translate into better team task performance. These studies suggest that organizations can be structured to capitalize on the benefits of various modes of communication. In fact, many guides to business management recommend various means of "flattening" organizational structures (i.e., reducing hierarchical levels and barriers to communication), promoting communication within and between teams, and reducing the use of impersonal communication media (email, memos, etc.) (e.g., Rotheram, la Cour, & Jacobs, 1982; Swartz, 1996).

Perceptions of organizational structure by employees and managers are also important determinants of communication. Bangs (1983) distinguished two kinds of management approaches that have different effects on employee perceptions. Macro-management involves forcing information up a chain of command by altering the structure of the organization or the nature of employees. Micro-management, in contrast, involves developing the communication abilities of superiors so that strong personal trust builds between superior and subordinates. The latter approach promotes more interaction of superior and subordinates and fosters perceptions of interdependency.

Bangs (1983) reviewed management literature and found that superiors' communications could be divided into those that were confirming, and which caused subordinates to feel more valued, and those that were disconfirming, and which caused subordinates to feel less valued (see Table 8.3). Thus, to build trust and promote open communication, organizations need to be structured in a way that restricts disapproval, judgmental behavior, and defensiveness and, instead, promotes acceptance of input and mutual responsiveness.

| Disconfirming Communication | Confirming Communication |
|---|---|
| Imperviousness | Direct acknowledgement |
| Interrupting response | Agreement about content |
| Irrelevant response | Clarifying response |
| Tangential response | Supportive response |
| Impersonal response | Supportive response |
| Incoherent response | Expression of positive feeling |
| Incongruent response | Listening |

**Table 8.3 - Kinds of Disconfirming and Confirming Communications in Organizations (Adapted from Bangs, 1983)**

The research reviewed in this section only scratches the surface of the literature pertaining to communication factors. Nevertheless, it illustrates a number of important classes of factors that likely play a major role in determining the sharing of intent. Table 8.4 lists these classes of factors, although the list is by no means a complete survey of communication factors. Perhaps the most important class of factors is the degree of common ground or shared knowledge   This points out that success in explicit communication and hence sharing explicit intent, will likely depend on the prior sharing of implicit intent. That is the common beliefs, values, and principles that will allow members of a military organization to establish both a common understanding of command intent and to act in accordance with it. For example, military teams with differing levels of technical diversity presumably share less common ground, and thus will exhibit different patterns of communication with different costs (in Clark and Brennan's terms), and such effectiveness and/or efficiency of communication will vary according to the medium used.

| Communication Factors |
|---|
| Common Ground<br>• Constraints<br>• Costs |
| Communication Medium<br>• Support for common ground<br>• Ease and speed of sharing information<br>• Feedback |
| Communication Strategy<br>• Appropriateness to content |
| Organizational Structure / Policy<br>• Openness<br>• Trust<br>• Degree and appropriateness of information sharing |

**Table 8.4 - Communication Factors Presumably Related to Sharing of Common intent**

## 8.2 Teamwork and Team Mental Models

Research has shown that effective teamwork and communication depend on shared common ground or team mental models (Brannick et al., 1995; Graetz et al., 1997; Rouse et al., 1992). Recall, for example, that Mohammed (1996) found that the extent to which mental models were shared determined team performance in a decision making task. Such findings make it important to understand the factors that affect the sharing of mental models because these factors ultimately affect how well teams can perform.

One factor revealed in the Mohammed (1996) study was the degree of acceptance of group knowledge. Having a shared mental model implies some degree of individual acceptance of the group knowledge structure; in other words, the individual "buys in" to a group model that differs in some respects from his or her own (Mohammed, 1996). Acceptance of the team mental model, however, can vary in its sincerity or strength. Social, task, and time pressures can lead individuals to publicly accept the group mental model (*operational consensus*) without private acceptance (*perceptual consensus*). Public consensus may not entail the same degree of commonality as private acceptance Thus, it is important to understand how an individual perceives the group and the need to accept it in order to predict how effective will be sharing of mental models.

The finding that a shared mental model benefits team performance assumes that the team's mental model is largely accurate and appropriate to the task at hand. Systematic errors and biases are possible in a team's knowledge and representation of the task domain. We would not expect teams to benefit from sharing a flawed mental model. (This point reflects those made in a previous section concerning outdated military doctrines based on experience of past battles that might be widely accepted but are inappropriate for the challenges of the day.)

Even when there is a large degree of acceptance on the part of individuals, sharing mental models may be difficult. Noakes et al. (1996) examined how teams combine team members' different areas of expertise and domain knowledge. They noted that many teams in diverse domains consist of people with highly differentiated roles, knowledge, and backgrounds. As a consequence, it is possible that members of a team have largely disjoint mental models, which can undermine cooperation and coordination and lead to conflict[20] Furthermore, individuals from different backgrounds may not be able to interpret what others bring to the team because they have a particular mental set. Noakes et al. (1996) observed that Australian Armed Forces teams used explicit coordination strategies to make sure that subtasks were divided rationally among members based on their expertise. There was, however, a need for monitoring to ensure that individuals interacted to gain and provide information, receive task assignments, and provide relevant feedback to the rest of the team.

In a broader sense, one function of a team mental model is to aid team members in adapting to the on-going situation. Thus, team members must predict the actions and needs of others' and tailor their communication and actions to support the rest of the team as well as their own specific tasks (Salas et al., 1997). This is the process of adaptation, which seems to go on at an implicit level in many team decision making situations (Entin et al., 1993; Salas et al., 1997; Shattuck, 1996). Different adaptation strategies, however, may be more or less effective in establishing shared mental models.

Research by Serfaty and colleagues has supported this premise (see Serfaty,Entin, & Johnston, 1998) by demonstrating that teams exhibiting superior performance on tasks under high workload employ different coordination strategies than those of inferior teams. Serfaty et al. (1998) suggested that adaptation rests on a shared mental model of the task and task environment and a shared mental model of the team in terms of team members' tasks and abilities. According to their Adaptive Team Model high-performing teams adapt their decision making, coordination, and organizational strategies under conditions of stress. By adjusting these components, the team as a whole maintains acceptable performance and manages the perceived stress at tolerable levels. The Adaptive Team Model implies that teams can employ a sensing strategy to assess the conditions (e.g., stress) demanding some adjustment and one or more adaptation strategies that influence the organizational structure and/or decision making and coordination strategies. The adaptation strategies may be explicit (based on communication) or implicit (based on a shared mental model). Adaptation strategies involve changing aspects of (McIntyre & Salas, 1995, cited in Serfaty et al., 1998):

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[20] Other studies reviewed invoke such team diversity and the processes for making the most of it as a factor in team success in widely differing domains for example Madhavan and Grover (1998), Hoopes and Postrel (1999), and Amason and Sapienza (1997).

- Team orientation.
- Communication behavior.
- Monitoring behavior.
- Feedback behavior.
- Backup behavior.
- Coordination behavior.

Wittenbaum et al. (1996) have proposed a somewhat different, but related, model of what they term anticipatory coordination. As discussed in Section 7.1, team coordination requires member expectations, which allow prediction of teammates, task assessment, and resource allocation. The team goal or purpose will affect how individuals estimate task, resources, and teammates, as well as their strategies for coordinating these aspects.In one study, Wittenbaum et al. (1996) had university students participate in either a *collective recall* or *group decision making* task. In both cases, participants studied an extensive set of information about three candidates for student president. Each team member could reduce his or her information processing demands by coordinating his or her effort based on the anticipated capabilities of other team members. Wittenbaum et al. (1996) manipulated the perceived capabilities of team members by either telling other members that a particular member had expertise in one domain or by giving only general social information from which to infer areas of expertise. Participants read the descriptions of the candidates by themselves then reviewed bogus questionnaires purportedly about other team members. The questionnaires indicated that other members had expertise in three of five topics covered in the candidate materials. All participants, even those who anticipated only a decision making task, were then given a recall test.

- The goal of the team for the *collective recall task* was to remember collectively as much as possible. Wittenbaum et al. expected that participants who anticipated this task would remember more topics that were *"free"* (no team member had expertise in that area) than "*taken*" (a team member purportedly had expertise in that area). In other words, participants were expected to focus their own study efforts on material that they (and not others) were perceived as better suited to study.
- The team goal for the *decision making task* was to integrate information to form individual preferences, then pool these to generate a group decision. Wittenbaum et al. expected participants who anticipated this task to remember more "*taken*" than *"free"* topics because they were expected focus on material they believed other members would also study in order to achieve a common frame of reference (mental model).

The results of the study confirmed Wittenbaum et al.'s (1996) expectations and indicated that participants tacitly coordinated with team members based on their perceptions of other members' expertise. In a subsequent experiment, Wittenbaum et al. (1996) found that team members tacitly coordinated their activities differently depending on the kind of decision rule the team was instructed to use. This result suggests that adaptation strategies are affected by other factors, such as organizational structure and team diversity. Indeed, it is likely that tacit coordination takes different forms in small team settings as opposed to a large organizational context.

Table 8.5 summarizes the factors associated with team mental models and, hence, the acquisition of common intent. The list of factors suggests that, in addition to the extent to which teams share mental models, the extent to which and how they employ them to adapt to the evolving task environment will also be affected

| **Teamwork and Team Mental Model Factors** |
|---|
| Coverage of Shared Mental Models<br>• Team members and roles<br>• Task procedures<br>• System features and capabilities |
| Extent of Shared Mental Models<br>• Acceptance<br>• Accuracy<br>• Self Awareness |
| Adaptation Strategies<br>• Communication<br>• Coordination<br>• Team orientation<br>• Monitoring behavior<br>• Feedback behavior<br>• Backup behavior |
| Tacit Coordination<br>• Member expectations<br>• Task assessment<br>• Resource allocation |
| Motivation |
| Satisfaction |

**Table 8.5 - Teamwork and Team Mental Model Factors Presumably Related to Sharing of common Intent**

## 8.3 Training

Many approaches to team training have focused on ensuring that required skills and knowledge are acquired by each member of the team (see Cannon-Bowers & Salas, 1997; Heffner, 1997). This has lead to particular kinds of methods and associated measures of effectiveness being developed. Recently, however, the adequacy of this approach has been called into question as more researchers have addressed the need to train teams in both task skills and team skills (Heffner, 1997). In light of the research indicating the importance of shared mental models, even this change in perspective may fall short

Training in team skills will support development of certain general processes for communicating and coordinating within a team structure. In addition to these skills, however, team members need knowledge and procedures for working with the specific members making up the team, within the context of the jobs and tasks the team is to perform (Heffner, 1997). Salas et al. (1997) has proposed that a basic objective of team training should be to foster in team members a common, accurate, and sufficient mental model of the team task structure, team role structure, and team members' knowledge and competencies. Such training would support not only the processes of teamwork and coordination but also provide the knowledge base needed to anticipate other members' information needs. Thus, a third component of team training should specifically target the development of shared mental models among team members.

Studies have supported this claim by showing that training aimed at fostering team mental models leads to better team task performance. In one study, Heffner (1997) examined two-person teams that completed missions using computer software that simulated F-16 fighter jet scenarios. Teams were randomly assigned to one of four training conditions:

- Task and team training by position (pilot and weapons controller).
- Task skills training by position and intact team skills training.
- Intact task skills training and team skills training by position.
- Intact task and team skills training.

The team skills training was the same in all conditions.

Heffner predicted that teams that trained as *intact teams* (i.e., pilot and weapons controller together) would also acquire more of a common team mental model than teams that trained by *position* (i.e., pilot with pilots separately from weapons controllers with weapons controllers). The greater the overlap in team members' mental models, the better should be their anticipatory coordination. Thus, Heffner also predicted that teams that underwent intact task and team training should exhibit the greatest sharing of mental models, followed by teams that underwent intact team skill training only. In turn, the degree of sharing of team members' mental models should predict the teamwork variables of communication, assertiveness, leadership, decision making, mission analysis, adaptability, and situational awareness.

The results showed that the degree of sharing did predict these teamwork variables, which in turn predicted team performance.[21] Contrary to expectation, however, teams that underwent intact task skill training actually developed more shared mental models than teams that underwent intact team skill training. It seems that learning about the tasks and responsibilities of the other team member was more useful in building a common mental model for the team. The study failed to determine a significant relationship between training condition and the sharing of team members' mental models. Given the strength of the literature indicating the role of shared mental models in promoting team performance, Heffner (1997) suggests that her training manipulations were simply not strong enough to produce differences in learning and behavior.

Further empirical studies are needed to clarify the relationship between type of training and the development of shared mental models. Nevertheless, researchers have advanced various training techniques to help teams acquire high quality team mental models. We will review three kinds of training techniques that vary in the explicitness with which they address team mental models during training. One, *Coordination Training*, provides trainees with explicit knowledge about the roles and tasks of other team members. The others, *Cross Training* and *Cooperative Learning*, provide experiences for implicit learning needs of other team members.

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[21] Team performance was enhanced only when teams had a shared mental model of high quality and accuracy (Heffner, 1997)

The first technique, *Coordination Training*, explicitly provides team members with mutual knowledge about team roles (Entin et al., 1993). This approach derives from training in general team skills. The difference emerges when team members are taught about the specific roles of other team members within the context of the tasks the team will perform. In this way, team members learn about the information needs, preferred communication patterns, and specific competencies of their teammates.

One particular training strategy developed in this technique is Team Adaptation and Coordination Training (TACT) (Salas et al., 1997; Entin, Serfaty, & Deckert, 1994, cited in Salas et al., 1997). TACT is conducted in three phases (Serfaty et al., 1998):

- **Phase 1**: Teams are taught how to identify signs and symptoms of stress in themselves, other team members, the team, and the environment, and they are instructed on the use of five general team coordination strategies.
- **Phase 2**: Participants view three pairs of videotaped vignettes demonstrating a team using good and poor strategies.
- **Phase 3**: Teams practice what they have learned by completing two 12-minute training scenarios and receiving and providing process feedback.

Experimental results of Entin et al. (1994, cited in Salas et al., 1997) indicated that teams that received TACT exhibited better teamwork and performed significantly better in naval C2 scenarios than teams that did not receive training. In particular, the TACT-trained teams were better able to adjust individual task work to maintain workload at an acceptable level and increase the communication of crucial information needed by the team leader. In a similar study, Serfaty et al. (1998) compared U.S. Navy CIC teams that had received either no training, TACT, or TACT plus periodic situation assessment updates. The teams that received TACT exhibited better teamwork in terms of Teamwork Observation Form scores, an instrument that assesses six dimensions of teamwork (team orientation, communication behavior, monitoring behavior, feedback behavior, backup behavior, coordination behavior). Furthermore, the teams that received TACT performed significantly better than those who had received no training. Periodic situation assessment updates seemed to help teams further enhance the congruence of team members' mental models because they validated the common knowledge and situational mental model shared by team members. Serfaty et al. (1998) concluded that training in both adaptive skills and shared knowledge are important determinants of team mental models.

The second technique is *Cross Training* (Schragen & Rasker, 1995). In cross training, each team member receives practical, hands-on training in the other job functions within the team This experience forms the basis of a common mental model of the team that all members shared. In particular, cross training is used to develop common shared expectations (inter-positional knowledge) regarding specific team member functioning (Salas et al., 1997).

The Team Model Trainer (TMT) is a version of cross training for CIC team members (Salas et al., 1997). TMT has been found to improve inter positional knowledge among CIC team members as well as knowledge about appropriate communications (Duncan, Cannon-Bowers, Johnston, & Salas, 1994, cited in Salas et al., 1997). This enhanced inter-positional knowledge led to better performance in naval Anti-Aircraft Warfare (AAW) scenarios.

The third technique is *Cooperative Learning*, which also uses an implicit approach to building team mental models. In this approach, trainees are forced to be mutually interdependent to achieve their learning goals. This can be achieved by *goal interdependence* or by resource interdependence.

- *Goal interdependence* is the perception that one can achieve one's goals if and only if all other group members achieve their goals.
- *Resource interdependence* is the perception that resources are divided so that each group member has only a portion of the resources needed to achieve goals (Johnson & Johnson, 1989).

In a study of air traffic control trainees, Johnson and Johnson (1989) found that cooperative learning produced better learning of technical information, better ability to perform job functions, and greater group cohesion than standard independent training techniques. In a subsequent study, they found that cooperative learning through goal interdependence produced greater motivation and higher perceptions of group support than cooperative learning through resource interdependence. Johnson and Johnson (1989) concluded that optimal cooperative learning situations should include five elements, shown in Table 8.6.

| **Essential Elements of Cooperative Learning** | |
|---|---|
| Positive Interdependence: | Perception that one is linked with others in a way that one cannot succeed unless others do (and vice versa), i.e., perception of mutuality and common fate |
| Face-to-Face Promotive Interaction: | Interaction in which trainees orally explain to each other how to solve problems, discuss the nature of concepts, teach one's knowledge to classmates, and explain connections between present and past learning |
| Individual Accountability: | Perceived mutual responsibility for the group to be successful; the performance of each individual trainee is assessed so that the group knows who needs more assistance in completing assignments. |
| Social skills: | Instruction in leadership, decision making, trust-building, communication, and conflict management skills. |
| Group Processing: | Discussion of how well the group is achieving goals and maintaining effective working relationships among members |

**Table 8.6 - Essential Elements of Cooperative Learning Situations** (Adapted from Johnson & Johnson, 1989)

Overall, these training techniques indicate that training strategies and programs based on the concept of the shared mental model can facilitate teams acquiring a shared mental model and performing complex team tasks more effectively. Based on their research in this area, Salas et al. (1997) make a number of recommendations for the design of team training:

- Foster shared or compatible mental models of the task and other team members' roles.
- Train team members on teamwork skills such as situation awareness, communication, team leadership, adaptability, and coordination behavior.
- Provide team members with guided practice on the skills needed to perform under naturalistic conditions.
- Develop simulations that allow team members to experience different courses of action.
- Provide practice and feedback to team members on each others' roles and build realistic expectations about the task requirements.
- Train team leaders to share situational awareness by providing periodic updates to team members.

Overall, it appears that the type of training teams receive will influence the extent to which they develop shared mental models and, presumably, shared intent. Note, however, the absence of reference to goals in contrast to tasks; i.e., a focus on the *how* rather than the *why*. Also that both explicit and implicit learning can contribute to the acquisition of common intent. Table 8.7 summarizes the factors associated with training.

| **Training Factors** |
|---|
| Coordination Training<br>• Explicitness<br>• Practice and feedback<br>• Realism |
| Cross Training<br>• Practice and feedback<br>• Group discussion<br>• Positive interdependence<br>• Face-to-face interaction<br>• Individual accountability<br>• Social skills<br>• Group processing |
| Length/Depth of Training |
| Linkage Between Training and Organizational Practices |
| Accuracy of Training |

**Table 8.7 - Training Factors Presumably Related to Sharing of Intent**

In the military context, especially within multi-specialist command teams, insight into the needs and manner of thinking of team members of other specialties is important. This may be combined with the challenge of team membership changes as resources are re-assigned to meet the needs of different missions, or individuals are replaced for one reason or another. This implies two aspects: understanding the needs of the different specialties (for example artillery or armour, sub-surface or air warfare) assigned to the team, and understanding the capabilities of the team member who represents that specialty for duration of the mission. For example members of the HALIFAX command team frequently commented on the lack of comprehension of the capabilities or needs of the different warfare specialties on the part of team members with different backgrounds (Webb & McLean 1997; Matthews & Webb 1999).

## 8.4 Organizational Structure and Diversity

The structure of an organization is a factor that affects many aspects of individual and team functioning. As described above in Section 8.1.3, it affects communication by either facilitating or hindering the transfer of information between certain elements within the organization It also affects coordination by determining the loci of decision making and planning (for example, requiring decisions to go up a chain of command or allowing elements low on the command chain to interact), as well asthe training available, resource allocation, and other factors that will constrain how the organization will work.

In this section, we will review several high-level aspects of organizational structure and examine their effect on shared mental models and team processes.

### 8.4.1 Organizational Philosophy

At a high level of analysis, we can consider the impact of the organizational climate, which can be thought to reflect the general openness and flexibility of the organization. Some researchers have characterized organizational climate in terms of its skills in creating, acquiring, and transforming knowledge and adapting to reflect new knowledge and insights (Gumbert, 1996, Weigel, 1997). A *learning organization* is one that possesses high degrees of these skills (Senge, 1990). Gumbert (1996) notes that a learning organization exhibits behaviors and knowledge that other organizations do not, as shown in Table 8.8. Learning organizations are able to evolve more rapidly because they question assumptions about the organization itself and actively seek new, outside perspectives (Gumbert, 1996; Senge, 1990). They do this by rewarding learning by individuals and groups within the organization and fostering more lateral communication and collaboration between groups.

| **CHARACTERISTICS OF LEARNING ORGANIZATIONS** |
|---|
| **What Learning Organizations Do that Other Organizations Do Not:** |
| • Learns collaboratively and across boundaries |
| • Values how it learns as well as what learns |
| • Invests in staying ahead of the learning curve in industry |
| • Gains competitive edge by learning faster and better than competition |
| • Turns data into useful knowledge quickly |
| • Exhibits little fear and defensiveness; rewards and learns from errors and success |
| • Invests in experimental learning |
| • De-politicizes learning; no penalties for sharing learning |
| **What Learning Organizations Learn that Other Organizations Do Not:** |
| • To use learning to reach goals |
| • To help people value effects of learning on org |
| • To avoid making same mistakes again |
| • To share info in ways that prompt appropriate action |
| • To link individual performance with organization performance |
| • To tie rewards to measures of performance |
| • To take in a lot of environmental information at all times |
| • To create structures and procedures that support learning process |
| • To foster ongoing and orderly dialogues |
| • To make it safe for people to share openly and take risks |

**Table 8.8 - Behavioral and Knowledge Characteristics of Learning Organizations (Adapted from Gumbert, 1996)**

Gumbert (1996) also argues that there are five disciplines or organizational skills that are needed to be a learning organization:

- **Personal mastery**: Technical and tactical competence plus an emphasis on learning to expand one's capabilities.
- **Mental models**: Development of, and reflection upon, deeply ingrained assumptions, ideas, beliefs, and procedures.
- **Team learning**: Developing collective skills so that the group can perform at a level greater than the sum of its parts.
- **Shared vision**: Commitment by organization members to work toward a common concept of the future.

- **Systems thinking**: Holistic, dynamic viewpoint used when analysing situations to determine cause and effect; focus on the relationships between arrangements of the various subsystems that operate in the environment.

The perspective of the learning organization has been recognized in some military contexts. U.S. Army doctrine, for example, supports some learning organization concepts (Gumbert, 1996) It promotes personal mastery and development of leadership at all levels, shared vision and common knowledge through training and experience, and close teamwork. Much of the research into team mental models has been conducted for the U.S. military.

### 8.4.2 Group Diversity

Although many researchers advocate the positive role of shared vision in an organization, other researchers note that a degree of diversity also benefits organizations, and is not incompatible with a common vision. Diversity in background, education, and experience among employees provides different perspectives on group problem solving (Knouse, 1996), which fosters more unique inputs and creative solutions. Diversity can also improve the overall organizational affect, which encompasses the pride in work, satisfaction, commitment to the organization and its clients, and cohesiveness of an organization (Knouse, 1996).

A potential problem of diversity within an organization, however, is that members will have such very different backgrounds and viewpoints that they will be unable to build cohesiveness and work effectively together. A major function of basic training in the military is to reduce these differences by bringing all members toward common practices and values. It is important to achieve both a degree of diversity to support creative work and a strong shared mental model to support communication, coordination, and efficient work. Based on previous research, Knight et al. (1999) hypothesized that demographic diversity (in terms of background, age, education, and employment tenure) of members of Top Management Teams (TMTs) would affect group processes and the extent to which teams formed a common mental model and strategic consensus. They examined TMTs from 83 high-tech firms and conducted interviews with TMT members. Results indicated that almost all aspects of demographic diversity (all but age) were significantly related to achieving a common mental model. Greater diversity in the group increased inter-personal conflict which in turn reduced the degree of agreement seeking. The processes of agreement seeking increased the probability of strategic consensus. These authors speculated that power differentials (such as differences in rank or experience) might also affect the probability and outcome of group agreement seeking processes. This result suggests that diversity is not itself the key factor determining group consensus. Rather, it is the use of group agreement-seeking processes, which becomes more important as group diversity increases.

Diversity is of particular significance to the military because of the size of that organization, the diverse population from which it draws its members, and the many specialized branches within it Diversity increases if reserve forces, other nationalities, or civil organizations are involved. Diversity can promote negative perceptions and emotions as well as inaccurate stereotypes of individuals and groups. This was demonstrated by Stenger (1997) in a study of mutual perceptions among military and civilian members of integrated product development teams. These teams required civilian contractors and members of the military to work together, with the military member of the team often in the role of team leader or project manager. Stenger found that the military members characterized the civilian members in largely negative terms, as clock-watchers, undedicated, motivated primarily by money, and poor leaders. They did concede that civilian contractors provided valuable continuity on projects. Civilian members similarly possessed negative views of military members, as primarily interested in their personal annual review rather than the team project and employing an arrogant leadership style. Civilians also believed that the military culture was extremely hostile to them. One can imagine other such dividing lines (though with different consequences) between groups within the military. Examples include differences between services (Army, Navy, and Air Force), between arms (support services and teeth arms), between regular and reserve force members, and between men and women. As Winslow (1998) notes, a downside of fostering pride in one's own unit may be contempt for the members of others.

A particular danger when dealing diversity in teams is the potential for conflict. Traditionally, researchers have thought of conflict as a factor that impairs decision making and team performance. Amason and Sapienza (1997), however, argue that conflict can be beneficial as well as detrimental, depending on the nature of the conflict. They distinguish between two forms of conflict. *Cognitive conflict* is task-oriented and arises from differences in perspective or judgment. In contrast, *affective conflict* is emotional and arises from personal disputes or incompatibilities. Cognitive conflict is beneficial to group functioning because it involves debate and exchange of information and ideas among team members. Affective conflict is detrimental to group functioning because it produces hostility, distrust, and other negative emotions among team members, which reduces the exchange of information and mutual commitment.

Unfortunately, both types of conflict can be brought about by the same conditions (Amason & Sapienza, 1997). This may be due to an inability by team members to distinguish and manage cognitive and affective conflict. To explore this issue, these authors examined the effects of team size, openness, and mutuality on the nature of conflict within TMTs. *Openness* refers to the team's propensity to encourage and engage in open, honest exchange of views. *Mutuality* refers to the extent to which team members believe that they are mutually responsible and will share the consequences of team decisions. Amason and Sapienza (1997) hypothesized that openness promotes cognitive conflict but mutuality will restrict cognitive conflict because team members will try to accommodate other team members. In contrast, they hypothesized that both openness and mutuality restrict affective conflict due to greater mutual understanding and responsibility. Large teams should experience more of both types of conflict than smaller teams due to greater opportunities for differences in views and perspectives. This implies also that, for a given team size, greater diversity (for example within service versus joint service operations) will give rise to greater conflict.

Amason and Sapienza (1997) measured openness for 48 TMTs with a rating task in which participants indicated their level of agreement with statements consistent with the free expression of ideas and encouragement of input. They measured mutuality with a similar scale using statements consistent with a collective orientation toward decision making. Cognitive and affective conflict were measured by the Interpersonal Conflict Scale (Jehn, 1992, 1994, cited in Amason & Sapienza, 1997) Amason and Sapienza (1997) found generally strong support for their hypotheses. Cognitive conflict increased with openness but decreased with mutuality, whereas affective conflict tended to decrease with openness and mutuality. Thus, strategies that promote openness and mutuality may help teams maintain cognitive conflict that aids team performance while reducing or maintaining affective conflict at a manageable level. Furthermore, the more diverse the team, the greater the need to balance and manage cognitive and affective conflict. This may compare with the superiority of goal based cooperative learning (Johnson & Johnson, 1989); i.e., the perception that one can achieve one's own goals only if all other group members can achieve theirs.

Another aspect of organizational openness is an organization's attention to, and acceptance of, *"whistle-blowers,"* individuals who identify problems and/or breaches of ethics or law within the organization. According to Greenberger, Miceli, and Cohen (1987), a large number of factors affect a person's decision to "blow the whistle." These factors are shown in Table 8.9, categorized into four types of factors: group characteristics, focal member (potential whistle-blower) characteristics, situational characteristics, and group norms about whistle-blowing. These factors determine a potential whistle-blower's perceptions of organization wrongdoing, likelihood of group sanctions, and group credibility. When factors conspire to produce the impression that the group will punish a whistle-blower, that the group is infallible, or that wrongdoing is unclear, an organization closes itself to internal criticism, which, in turn, can lead to perpetuation of unlawful, unethical, and harmful behaviors (cf. Winslow, 1998).

| Type of Factor | Specific Factors |
|---|---|
| Group Characteristics | Group size<br>Cohesiveness<br>Credibility<br>Unanimity<br>Use of rewards and punishments |
| Focal Member Characteristics | Idiosyncrasy credits (group tolerance)<br>Desire for distinctiveness<br>Competence |
| Situation Characteristics | Task difficulty<br>Need for mutual assistance<br>Ambiguity of wrongdoing<br>Outside threat to group |
| Group Norms | Norms about wrongdoing<br>Norms about whistle-blowing<br>Enforcement of norms |

**Table 8.9 - Factors Determining Whistle-Blowing (Adapted from Greenberger et al., 1987)**

Greenberger et al. (1987) argue that organizations must eliminate negative consequences of whistle-blowing in order to maintain an climate of trust and openness. Among their specific suggestions are six management practices that promote whistle-blowing by decreasing group pressure to conform or altering group behavior after whistle-blowing has occurred:

- Organization leaders must assess norms regarding identification and reporting of wrongdoing and alter norms against whistle-blowing.
- Deviance by whistle-blowing should be made more attractive.
- The group and organization should alter their reward systems by targeting key individuals and by planning to work with and reward those persons for whistle-blowing in meaningful ways.
- The organization should place a strong advocate for whistle-blowing in the group.
- Reinforce credibility of those who blow the whistle.
- Structure work groups and tasks to promote less interdependence.

Greenberger et al (1987) do not comment on this, but another factor in operational groups with members drawn from diverse specialties may be the relative strength of the affiliation with the two groups - the parent group and the foster group. In such cases, one might expect split loyalties.

Examples of parent groups might include religious, family, or professional groups (such as physicians, engineers, or even different military specialties) with strong technical and/or ethical ties. Examples of foster groups would be the organizations in which individuals currently find themselves, with a tendency to shorter term membership of the foster group (cf., the Somalia incident discussed above).

Weigel (1997) has documented pronounced divisions between groups within a larger organization. Specifically, Weigel interviewed sea-based and shore-based Civilian Mariners (CIVMARS) working under contract for the U.S. Navy under the supervision of the Military Sealift Command (MSC). MSC manages military ocean transportation, although its customer base has expanded in recent years. Weigel interviewed sea-based and shore-based CIVMARS in small groups and analysed their views concerning the other sub-group. The interviews revealed that both sea-based and shore-based CIVMARS felt they were not valued by MSC and their concerns did not receive attention. Relations between afloat and ashore personnel were also characterized by distrust and poor communication CIVMARS afloat believed ashore personnel were not responsible and did not keep them abreast of issues such as training and development opportunities. Ashore personnel, in turn, felt sea-based CIVMARS were not honest in reports (about availability, etc.). Weigel (1997) argued that a characteristic of weak organizations is that different parts of the organization hold fundamentally different beliefs. This creates problems for morale and satisfactions of individuals and for cohesion, communication, and cooperation among sub-groups. On a lesser scale, pecking orders and pre-conceptions could well affect working relationships among the military specialties that exist within a command team. Weigel's study mirrors some of the divisions between military and civilian members of integrated product teams (Stenger 1997) cited earlier.

Table 8.10 summarizes the factors associated with organizational structure and diversity.

| **Organizational Structure and Diversity Factors** |
|---|
| Organizational Structure |
| Learning organization skills |
| Size |
| Openness |
| Mutuality |
| Internal communication |
| Diversity |
| Cultural/Ethnic |
| Educational |
| Age |
| Background |
| Organizational tenure |
| Functional specialty |
| Conflict |
| Cognitive |
| Affective |

**Table 8.10 - Organizational Structure & Diversity Factors Presumably Related to Sharing of Intent**

## 8.5 Research Implications

Based on the review in this section, we expect that sharing of intent for a given mission among team members in the command settings outlined in Section 2.6 will be affected by:

- *Communication issues* such as the feedback used to establish and confirm a common ground or mental model of understanding and terminology for two or more people to communicate effectively, the costs and constraints of sharing information using different media (such as face-to-face or auditory nets), and the significance of different forms of organizational structure for promoting or inhibiting communication laterally or vertically.
- *Team issues* such as training in team mental models (so that teams manage their communications in terms of common insights into mission related tasks[22], into team processes including the roles and capabilities of current team members, and the characteristics of the system (equipment, terrain, weather, enemy forces) within which the team must operate.
- *The level of diversity* and the group processes used to minimize the negative effects of diversity and maximize the positive effects to achieve a productive problem-solving environment in which the information held by different team members will be most effectively pooled to solve common problems, including the expression of dissent.

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[22] Discussion in the literature tends to focus on procedural rather than goal-based aspects of tasks

# 9. Enhancing Shared Intent

The literature reviewed so far has established a strong relationship among concepts such as common intent, team mental models, and group processes for maximizing the effectiveness of teams in performing tasks. The implication (and sometimes the motive for the research in the first place) is that effective sharing of common intent will be enhanced by steps that enhance communication and adaptation processes among team members.

In this section, we briefly relate concepts in the literature to common intent and then discuss potential applications in the context of long, medium, and short-term mission preparation activities.

## 9.1 Framework for Enhancing Common Intent

The overlapping aspects of team mental models, group processes, and communication are to be viewed in the context of military command. Military command teams can be seen as diverse multi-functional groups with the degree of diversity varying according to the level in the organization and the nature of the mission. As the CF is called upon to participate in a greater range of operations, diversity can be expected to increase as membership reaches out to include other services, nationalities, civil organizations, and community stakeholders. The stability and duration of command team membership may also fluctuate due to re-grouping of resources, postings, casualties, and so on, and this will affect the extent to which members share common values and knowledge.

A command team works to first formulate, and then implement, plans within a hierarchy of command intent whereby higher levels of command delegate selected responsibilities or missions to different units or groups of units. To achieve the purpose at one level requires the levels below to dovetail in terms of planning and implementation. Thus, any given command team must work with other command teams, some above in the chain of command, some lateral, and some below. Some of the directions a team receives are explicit in the form of direct orders although the medium of communication may vary (radio, face to face, text message). Other examples of explicit directions include procedures and constraints based on sources such as doctrine, training, and standing orders, and taken for granted. Implicit directions are more difficult to identify but likely include the transfer of values, attitudes, and beliefs that occurs through personal interactions, organization practices and rituals, and similar social interactions.

The mission will be performed within a given '*environment*' comprising not only terrain and climate but also resources, enemy and civil activities, friendly force activities, and the capabilities of the various equipment systems involved. Implementation of any plan depends on awareness, interpretation and reaction to this context of operations at the moment in question, in the light of perceived goals.

Depending on the requirement for synchronization and the capabilities of the participants in relation to the demands placed upon them and assumptions about what directions may be left implicit, perceived needs for centralization and the balance between what is made explicit and what left implicit may vary

### 9.1.1 Enhancing the Sharing of Intent

In this section, we identify means of enhancing the sharing of intent. The foundations are laid at the level of the whole organization, focused at the unit level, and used during specific missions. Many of these activities are undoubtedly already practiced to a greater or lesser degree within different military organizations.

**Service wide activities.**

These activities should enhance shared intent in any context. They target the enhancement of shared implicit intent and facilitate common intent by creating an organizational climate for productive cooperation for members of groups that will have to work together as well as common mental models about relevant issues. Broadly speaking, activities include:

- Preparing an organizational culture that favours effective sharing of information and development of common mental models;
- Determining appropriate group processes that support effective command decision making;
- Establishing the content required for effective team mental models; and
- Using socialization and training techniques to establish those models and processes among the members of the organization.

These activities may affect only a small portion of shared implicit intent. To some extent, success in these strategies depends on long range forecasts of likely missions and their nature since these will determine important factors related to the content of team mental models such as the team diversity, team tasks, and the likely context of operations. This sort of preparation is likely to be woven into the background of every military career and may be acquired in many ways, including participation in unit activities.

**Unit based activities:**

Given that individual members have acquired the generic mental models and understanding of appropriate group processes, individual military units will have to bring these into focus around particular team members and particular types of missions. This will require using previously learned group processes to:

- Establish the degree of shared intent among team members,
- Focus the content of mental models,
- Build trust amongst members of a specific group,
- Understand of the capabilities of specific individuals,
- Practice specific command procedures to know what must be made explicit and what can be left implicit.

This sort of preparation might well take place within a particular unit or group of units as they prepare for a tour of duty in a particular theatre.

**Mission based activities:**

These activities apply to a specific mission, a specific team with specific goals and tasks, in a specific context. Short-term, mission-specific factors act largely in relation to ensuring common understanding of explicit communications about a specific mission, such as statements of command intent and the limits on the exercise of initiative these impose. The activities will depend, to some extent, on successful implementation of the pre-mission activities to establish common intent. This category addresses issues and processes such as the format and content of explicit command intent statements, different means of confirming that intent is comprehended, rehearsals of different mission scenarios, use of lateral communication, and the like. The experience of the mission itself will act to further reinforce or weaken team mental models and trust.

### 9.1.2 Enhancing the Transformation of Shared Intent into Effective Performance

Selected activities and their roots in the literature are outlined below. These activities have been grouped in terms of organizational culture, group processes, training, support tools, and procedures related to the generation and use of command intent. They are not presented in any particular order of priority.

#### *9.1.2.1 Promote a favourable organizational culture.*

Research shows that the attitudes, values, and practices of an organization greatly affect how teams work (e.g., Cannon-Bowers, Tannenbaum, Salas, & Volpe, 1995; Jeong, 1998). The presence of a strong, universally accepted organizational culture can enhance the sharing of information, the overlap of organization members' mental models, and the sharing of values and attitudes. An important aspect of the organizational climate is its orientation toward collectiveness, which reflects the organization's degree of belief in the team approach and the extent to which it values collective work and decision making (Kraiger et al., 1997). An organization's collective orientation will determine the kinds of rewards and restrictions (formal or informal) it places on communication and information sharing; e.g., reward systems, team structures, training, distribution of authority, team orientation, richness of personal interaction, mutual trust, and so on (Madhavan & Grover, 1996). Techniques such as collaborative learning are ways to enhance the collective orientation of teams and facilitate common mental models (Jeong, 1998). The earlier discussion of *aufragstaktik* as a military philosophy that requires subordinates to exercise initiative in ambiguous situations makes it clear that a pre-requisite for such a philosophy to work in practice is an organizational culture of mutual trust. More specific means to promote a favourable organizational culture include:

**Encourage group participation and responsibility.**

De Vries' (1999) study highlighted the importance of active participation within open organizations. It is important for members of the organization to feel personally responsible for his or her functions as well as for providing support to teammates. Perceived mutual responsibility within a group enhances performance because the group knows who needs more assistance in completing assignments (Johnson & Johnson, 1989).

**Foster mutual respect and trust.**

Some of the research reviewed indicates the influence of trust on teamwork and team performance (e.g., Madhavan & Grover, 1996). A basic requirement for a team to function well is that members share commitment to team goals and the team itself and perceive the commitment of other members. This encourages and facilitates personal interaction and reduces negative emotions related to conflict and stress. Trust and respect among team members can be built through rich, personal communication strategies (i.e., face-to-face), and fostering a sense of interdependency among members Organizations should be structured to avoid disapproval, judgmental attitudes or behavior, and defensiveness.

**Reduce the negative consequences of whistle-blowing.**

Whistle-blowing can be a positive thing for organizations. Once there are major problems or breaches of ethics or law within the organization, a whistle-blower helps the organization recognize and deal with these issues (Greenberger et al., 1987; Winslow, 1998). There should be effective mechanisms for bringing forward and dealing with organizational factors that create a breeding ground for errors and problems before they have consequences that are difficult to manage. Given the immediate, short-term negative effects (public scrutiny, criticism, potential monetary costs), organizations often foster organizational norms and practices that punish and deter potential whistle-blowers. This, in turn, can contribute to mistrust and disrupts team orientation throughout the organization (Greenberger et al., 1987). Ironically, this may also increase the probability of the very event such preventive measures are intended to discourage. Thus, to promote teamwork, an organization should ensure that its management practices do not discourage those who come forward to report problems.

**Increase the longevity of functional teams.**

Trust and patterns of open communication develop over time. We should expect teams to show a learning curve in terms of their shared mental models as members interact and learn about their roles, their teammates, and the structure of the team tasks. Thus, promoting longevity of teams is one way to enhance team effectiveness (Heffner, 1996). Long-standing teams will show better anticipation and coordination than newly formed teams, albeit at the potential cost of reduced creativity (Bryant, 2000). It is not feasible in the military to keep teams together indefinitely but military organizations can recognize the potential benefits of keeping the same personnel together where possible.

### *9.1.2.2 Group processes*

The literature identifies group processes that facilitate effective pooling of knowledge. We recommend the following ways to enhance the effectiveness of groups:

**Mitigate the potential negative effects of diversity.**

Diversity can have beneficial effects on team creativity and adaptability (Gumbert, 1996; Knouse, 1996). It can also be a source of conflict among team members (Amason & Sapienza, 1997). When individuals come from very diverse backgrounds, they may be unable to reconcile their different perspectives in a common mental model (see Weigel, 1997; Winslow, 1998). In such cases, an organization should seek methods to help individuals recognize relevant differences and seek a shared mental model or common ground among team members with diverse backgrounds. Some of the research cited (e.g. Stenger 1997) represents organizational attempts to establish the consequences of different sources of such diversity as a prelude to addressing the problems.

**Promote cognitive conflict and restrict affective conflict.**

Amason and Sapienza (1997) distinguished between *cognitive conflict*, which is task-oriented and arises from differences in perspective or judgment on technical or operational issues, and *affective conflict*, which is emotional and arises from personal disputes or incompatibilities. They found that the prevalence of both kinds of conflict are influenced by the openness and mutual responsibility of members of a group. Promoting cognitive conflict should facilitate communication, help teams achieve shared mental models, and improve problem resolution and/or creative thinking. Affective conflict can impair the psychological contract linking members of a group, which reduces the sharing of views, which makes it less likely members form a shared mental model (Thomas & Anderson, 1998)

Affective or emotional conflict will reduce trust and mutual respect, whereas cognitive conflict will facilitate communication and the exchange of ideas (Amason & Sapienza, 1997). Consequently, organizations should develop methods (training, management practices) that promote the cognitive conflict but reduce, or mitigate the effects of, the affective conflict.

**Promote open dialogue.**

Openness is a key factor that promotes communication (Kraiger & Wenzel, 1997). The value of free communication within teams and between levels within an organization is supported by several lines of research ranging from African villagers to high-tech product development teams. At one extreme, De Vries (1999), for example, found open dialogue involving all village members with little differences in empowerment lead to strong village norms and problem solving practices that are commonly understood and respected. Mohammed (1996) has similarly observed that product development teams engage in group negotiation in which team members actively share assumptions and perceptions of issues. In general, an organizational climate that supports communication without the fear of negative consequences is associated with more creative and effective teams (Gumbert, 1996). An open climate also makes it easier for high-level decision makers to face questions about plans and practices and adapt to changing circumstances. Barriers to open dialogue include mistrust about team members capabilities or motives and differences in empowerment such as rank, experience, and perceived relevance of specialty knowledge.

Just as open communication enhances the sharing of mental models, it also helps develop strong teamwork and mutual responsibility (De Vries, 1999; Kraiger & Wenzel, 1997). It is important for an organization, as a part of open communication, to create a climate in which individuals can air and resolve conflicts that might otherwise lead to mistrust and a weakening of overall team orientation. For this to happen, there must be mutual trust in the group processes involved, for example that revealing a weakness will not be counterproductive for the individual.

**Promote 'common ground' among all organization members.**

Having a common knowledge base is critical for communication. Clark and his colleagues (e.g., Brennan & Clark, 1996; Clark & Brennan, 1991; Isaacs & Clark, 1987; Schober & Clark, 1989) have used the term 'common ground' to denote this component of communication. Common ground provides a shared knowledge structure with which to interpret messages from others and, equally important, to tailor one's own messages to be understandable by others (Clark & Brennan, 1991). Common ground is established by both verbal and non-verbal cues between people involved in any dialogue. Organizations can enhance the common ground its members share by ensuring that its members understand and practice the processes involved and by considering how different communication technologies affect it, and making allowances. Clark and Brennan (1991) identified a number of constraints that can limit common ground and associated them with different communication media. Generally, more face-to-face communication can help individuals establish common ground but depending on the content, other communication modes can be exploited. Research on common ground appears to have been conducted in terms of dialogue between two individuals rather than among members of a team of diverse specialists working in within a limited time frame. Translating existing common ground research to the military context and broadening it to encompass small teams should provide worthwhile insights.

**Establish distributed decision making practices.**

In many situations, teams function highly effectively under distributed leadership and decision making (De Vries, 1998; Madhavan & Grover, 1998; Noakes et al., 1996) This is particularly true for teams that work on complex, ill-defined problems for which information is limited and there are multiple potential approaches, as is likely to occur in some military situations. Teams well suited to working on such problems tend to have differentiated roles and knowledge, but a high degree of interdependence, so that each decision maker has a limited role and works on limited parts of problems (Noakes et al , 1996). A distributed decision making organization implies distributed leadership, in which there is no single authority (De Vries, 1998; Madhavan & Grover, 1998). This structure is participatory and involves all members of the team and gives all members the power to challenge authority on the basis of his or her own beliefs. Distributed decision making is encouraged by a leadership and organization that are willing to share goals, treat members with respect, listen to feedback, and address problems (De Vries, 1998; see also Bryant, 2000). This style of decision making will, of course, not be suited to all military contexts or organizational structures.

#### *9.1.2.3 Training Content and Procedures*

The processes of establishing common intent and using it during a mission to achieve more effective command and control needs training and practice. Some possible ways to enhance the establishment and use of common intent through training and practice include:

**Assess and promulgate Tacit Knowledge.**

Tacit Knowledge is, by definition, of practical value but not organizationally supported. Consequently, gains in command team performance may be achieved by explicitly identifying TK components of effective military command and teaching it to others (Horvath et al.,1994b). For example, Horvath et al.'s (1994a) TK Survey approaches could be used to survey Tacit Knowledge related to mission command (as opposed to leadership) and the generation and use of command intent statements. This knowledge could then be used in developing a training curriculum for command team members.

**Establish procedures to create and use statements of command intent.**

Shattuck (1996) describes the military doctrine of mission command whereby subordinate commanders use the higher commanders' intent to guide their response to changing circumstances; i.e., the disciplined exercise of initiative. This entails using higher intent to assess the situation, paying close attention to the kinds of data needed to evaluate the current applicability of the concept of operations (see also Builder et al., 1999) and passing that information (and no more) to the next higher commander. Although he makes no specific recommendations concerning training techniques, Shattuck does indicate that statements of command intent appear difficult to formulate and use. He suggests components of successful use of intent that might be taught to commanders:

1. Accurate assessment of the local situation in terms of their own goals, the goals of adjacent commanders, the higher commander, and the organization as a whole.
2. Identification of the procedure that most closely fits the situation.
3. Use specific information (e.g., the enemy has already bypassed the engagement area) to determine if the procedure should be modified.
4. Use the intent of higher and lateral commanders to bound adaptation of the procedure.

Shattuck also describes a debate over the format and scope of statements of command intent; i.e., whether to include solely purpose and desired end state or to add an outline of method of achievement. Shattuck discusses the need for subordinates to cultivate awareness in terms of the higher commanders intent so that, in a geographically distributed command network, only the information most appropriate for command decisions is selected and transmitted. Builder et al.'s (1999) analysis of command concepts expands this argument. They suggest a number of elements that need to be communicated effectively to subordinates to guide their decisions and to act as a filter for feedback to higher command to about the continuing validity of the concept of operations.

Given the importance of a common understanding of command intent among subordinate commanders, Shattuck describes several mechanisms for communicating command intent, making intent easy to understand and recall when needed, and confirming that team members, subordinates and superiors have a common comprehension of intent at several different levels.

**Support awareness of mission intent hierarchies.**

Shattuck's (1996) training recommendations indicate the importance of awareness based on indicators of the higher commander's intent. In a distributed command hierarchy, local commanders are expected to modify plans if the situation changes and the plan becomes unworkable or irrelevant to the mission intent. The local command, however, has a fundamentally different perspective than the higher command. For the local commander to act within the intent of the higher commander he or she must have awareness of the objectives, methods, and preferences of the higher commander (and also lateral command). The higher commander requires awareness of the subordinate commander perspective insofar as it related to command intent at his or her own level and above, if effective goal related decisions are to be taken. Thus, there is a reciprocal relationship of awareness needs.

Shattuck observed that failures to act within higher commander's intent occurred when subordinate commanders lacked a clear understanding of intent and/or how the situation related to the higher commander's intent. Builder et al. (1999) also make the point that subordinates must have a clear comprehension of command vision so that they can seek, collate and filter feedback appropriately for the perspective of higher command. If this is not done, then not only may higher command become overburdened with details, but it may focus at an inappropriate level.

Serfaty et al. (1998) also argues that awareness is critical for small team functioning and suggest that effective adaptation rests on a shared mental model of the task and task environment and a shared mental model of the team in terms of other team members' tasks and abilities. Their Adaptive Team Model implies that team members actively assess the conditions (e.g., stress) and situational factors that require some adaptation of the team structure or strategy. Specific monitoring and feedback activities are used to share situation awareness, which is incorporated in the team mental model.

Several researchers have stressed the importance of intent-oriented awareness (Shattuck, 1996; Serfaty et al., 1998). Effective communication of intent requires that all key elements are conveyed. Thus, the situational indicators pertaining to intent (i.e., information pertaining to the objectives, methods, and resources of an operation) should be made the foci of communication. This can be accomplished through training on how to convey intent and by developing organization-wide guidelines and formats for communicating intent.

The term '*situation awareness*' is sometimes used in the literature to denote these matters. However, we believe that, although related, the issues discussed here are different in focus and broader in scope than intended by the common use of that term (e.g., Endsley 1995). That use derives more from the tactical needs of fighter pilots and focuses more on tactical space and time issues rather than the awareness needs of unit commanders for command intent and concepts of operations. For that reason, we prefer the term "*mission awareness*" in the context of command intent to reflect this difference.

**Develop training in team coordination strategies.**

Various forms of training, including coordination training, cross training, and cooperative training can teach practical domain-based skills as well as team coordination skills while also providing insight to the capabilities of specific team members (Entin et al 1993). Coordination training can provide two benefits. First, it enhances skills that facilitate sharing of knowledge, values, beliefs, attitudes, and, hence, common intent. Second, such training provides some of the knowledge base necessary to anticipate the needs of teammates and to support them with task-relevant information and resources.

Various team training methods help teams develop shared mental models, which in turn facilitate teamwork (Entin et al., 1993). Training of general team skills, including communication strategies, coordination, and trust-building activities can benefit individuals as they move from one team setting to another. Similarly, adaptation training can help individuals monitor and modify team functioning. Once again, establishing TK inventories is likely to provide an important foundation.

**Actively socialize newcomers.**

Socialization is comprised of social processes by which a group or organization explicitly or implicitly instructs newcomers in the values, beliefs, attitudes, and practices of the group or organization. Guimond (1995) suggests that socialization entails an *encounter* phase, during which newcomers learn about the organization, and a *metamorphosis* phase, during which newcomers reconcile differences between their personal views and those of the organization. An organization can promote and support both phases through training, counseling, and other means. Evidence indicates that socialization promotes common understanding and better team mental models and suggests that an organization should make explicit steps to socialize newcomers (Thomas & Anderson, 1998): Rayer (1998), for example, has suggested a number of measures to support socialization. All military organizations, including the CF, engage in socialization through training, regimental traditions, and other means. It is likely worthwhile, however, to pursue socialization techniques that can be used whenever anyone joins a new group within the military (for example as staff officers join a new head quarters or individuals are posted to a new unit) and not just during training as a recruit or a technical specialist

**Promote experiential learning.**

One means advocated in the literature for the acquisition of TK is experiential learning; that is, learning by performing on-the-job or in very realistic scenarios (Horvath et al., 1994a). Based on command related TK identified through TK inventories, opportunities for on-the-job experience could be developed by level of command, area of specialization, and type of mission to promote acquisition of TK. The value of experiential learning is that it capitalizes on human observational and procedural learning capabilities to acquire and integrate knowledge and procedures that may be difficult to articulate in an explicit training regimen. Although the military already engages extensively in such training, using the TK survey approach could be used verify the current content and focus training more closely on issues related to command intent.

### *9.1.2.4 Support tools*

Technology can support or inhibit group processes for sharing or using common intent, and/or bias the balance between explicit and implicit intent by putting obstacles in the way of one or the other. For example, different communication media (e.g., text, auditory, or video) permit different levels of non-verbal feedback The following are some proposed technological means to support common intent:

### Develop technological support for more personalized communication.

Research on common ground by Clark and colleagues, Shattuck's research on sharing intent, and Madhavan and Grover's concept of RPI (Rich Personal Interaction) indicate that the feedback provided by face-to-face interaction is perhaps the most effective way of sharing intent, confirming intent is understood, or pooling knowledge. However, it may not always be possible for team members to meet and have long, personal discussions about objectives and plans. Thus, there is a need to develop remote communication systems that emulate the key features of face-to-face interactions without requiring excessive bandwidth or transferring too much irrelevant information. Approaches to this problem might include better use of graphic displays, which can transfer a great deal of information but also be designed to make intent-related information more salient (Noakes et al., 1996). Another approach is to limit dependence on forms of electronic communication with known limitations, such as e-mail. (See also comments on visualization tools below.)

### Create an organization-wide database to promote collective memory.

The larger an organization becomes, the more difficult it is to share information among its members. Organizational memory, the sum total of knowledge within the organization, can be divided into two components: information known personally to members of the organization and information not personally known by members but which can be retrieved when required (Anand, Manz, & Glick, 1998). Thus, for effective sharing, information must be stored in a way that makes it easy for people to retrieve and access. To do that, the organization must develop formal or informal directories (information about the existence and location of information available in the organization) and ensure that these are distributed to all members (Anand et al., 1998). This can also occur at the unit level. One example is the recommendation (Webb & Tack, 1993) that Divisional and Brigade headquarters provide a database of organization and team information for new arrivals to the team (such as augmentees and replacements) to speed their assimilation into the headquarters operations.

Organizations also need to incorporate *soft knowledge* into its collective memory (Anand et al., 1998). Soft knowledge consists of the beliefs, values, and attitudes of the organization and can be seen as essentially equivalent to implicit intent, in the sense of Pigeau and McCann. One way an organization can make relevant knowledge more readily available to individuals or groups is to develop *locators* (Anand et al., 1998). Locators are specialists or organizational entities dedicated to the management of organizational knowledge. Although these human locators are the key elements of a support system to promulgating soft knowledge, they can themselves be supported with various electronic media and computerized databases. An example of such an approach may be the increasing use in the military of organizations dedicated to capturing and promulgating lessons learned from exercises and operations through interviews and post operational analyses. Informally, many organizations have individuals who acquire the reputation of being the person for newcomers to consult about local procedures and personalities. These people or the forms of media suggested above could form an important source of tacit knowledge.

### Develop visualization tools that enable a common representation of the situation.

From the accounts presented in the literature (Entin et al., 1993; Noakes et al., 1996; Salas et al., 1992; Shattuck, 1996), a shared mental model is constructed from interactions among individuals during which they share perceptions, information, and knowledge. This construction is largely supported by dialogue (Finley, 1997; Madhavan & Grover, 1998; Mohammed, 1996) and tacit coordination among members (Entin et al., 1993; Stasser & Hinkle, 1996; Wittenbaum et al., 1996). The process, however, may be enhanced by development of visualization tools that enable an external medium in which to form a common representation of the situation (Noakes et al., 1996). Further support in the form of tools to diagram and annotate the common visual representation would enhance individuals' ability to exchange information, especially across technical boundaries in diverse teams A visualization tool could provide an observable depiction of a group's shared intent. A related idea may be Shattuck's (1995) suggestion to provide a readily accessible representation of the hierarchy of command intent statements to permit ready reference for subordinate commands which need to dovetail plans as they are being formulated or modified.

**Develop tools to support tacit coordination.**

If tacit knowledge underlying coordination strategies used by military C2 teams could be identified, this might be used to develop decision support tools that facilitate coordination, either by helping individuals recognize the cues that initiate coordination processes or by facilitating rapid adaptation of team structure or procedures. Such research could be guided by the three established components of tacit coordination and team mental models; i.e., team processes, roles and members, task goals and procedures, and system characteristics and resources.

Research has also shown that a significant coordination process is the adjustment of communication patterns to ensure the appropriate transfer of information (e.g., Entin et al., 1993). Thus, tacit coordination could be supported by developing communication links and visualization tools to idealize communication among team members by anticipating, filtering and collating information in terms of the needs of other team members.

# 10. Measures and Methods

In this section, we describe measures and methods that may be applied in the study of Common Intent. First, we will describe general approaches to examining common intent. Some of these approaches have already been employed in research to examine concepts of shared mental models, coordination, teamwork, decision making, and communication that are related to common intent. Other approaches, although not yet employed, appear viable. Second, we will describe specific methods, again some of which have already been employed in relevant research. Finally, using a framework employed by Matthews, Webb, and Bryant (1999), we present specific measures and methods in tabular form organized by the area of study from which they were drawn.

## 10.1 Approaches

Before examining specific measures and methods, we will briefly review some standard research paradigms and their applicability to examining intent and related concepts.

### 10.1.1 Experimental Research

Experiments generally follow a design in which one or more *independent variables* of interest (such as sources of team diversity or some aspect of team mental models) is varied and the effect of the variation measured in terms of other *dependent variables*. Dependent variables consist of various measures, as will be discussed shortly, for assessing how well participants perform tasks (such as speed, accuracy, timeliness), the kinds of strategies or processes they use (such as anticipating the information needs of others), or subjective outcomes (such as trust in other team members, or perceived workload).

In addition to the dependent and independent variables, care must be taken to control relevant background conditions or the results may not be valid for the application of interest. For work on intent, the literature reviewed repeatedly expresses concerns that absence of certain conditions, discussed below, may undermine the validity of any results. It is therefore considered extremely important that these conditions be borne in mind when designing specific studies. The reason that these conditions have been circumvented in the past is that they represent onerous requirements that are demanding in terms of scarce resources. However, failure to attend to them, risks wasting any effort invested.

First, participants should be representative of the target user population.[23] In this case, this means military personnel with appropriate training and experience, a rather scarce resource. For studies of mental models or common intent, it will be particularly important to account for participant backgrounds in terms of training and experience and to ensure that background is both consistent across different participants with respect to the focus of the study, and appropriate for the experimental task set. For example, requiring undergraduate students with no military background to complete a simulated military task may not generate results that are representative of the way the task would be approached by experienced members of the military.

Second, the experimental task should closely represent what users will have to do in the real world. Even with sophisticated simulation, this is a difficult requirement to fulfill for many military tasks. However,

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[23] This point applies to all research approaches.

"closely represent" does not have to mean 100% fidelity for all aspects of the context of interest. In many cases, a careful task analysis to isolate key dimensions of interest, and a review by Subject Matter Experts (SMEs) to confirm that the task chosen represents the essential challenges of the real life task will be sufficient and far less costly.

Third, the experimental procedures must not constrain or bias participants' performance by suggesting, explicitly or implicitly, a particular strategy or by limiting their options. Such a bias can be difficult to second guess. For this reason, among others, a pilot trial of the study procedures is essential to ensure that no unforeseen strategy for task completion is being employed by participants.

Finally, for team studies, the composition of the team in terms of experience with the other team members, diversity of background among team members, and experience with team processes in general, will be important. For this reason, longitudinal studies should be considered in which a team, once formed for the study, undertakes a series of similar tasks, so that team members acquire tacit knowledge about the team and the task. In this context, statistical design to ensure balance among successive conditions will be of paramount importance.

Although these prescriptions support the widely held view that the experimental task and procedures must capture key features of a realistic working environment, conducting experiments in artificial contexts can clarify theoretical issues, provided the key dimensions of interest are carefully isolated and their pertinence established.

### 10.1.2 Field Observation

Often, it is not possible to conduct laboratory-based experiments due to constraints of time, money, or the availability of participants. In other cases, the research issues may not be amenable to laboratory research. Another common way to examine performance is by conducting structured observations in the field (Adelman, 1992, Ch. 5). There are several forms of field observation

A *quasi-experiment* is, in structure, the same as an experiment, with the researcher defining independent and dependent variables, experimental controls, and selecting participants. In a quasi-experiment, however, practical constraints may limit the researcher's control over these issues and over extraneous variables.

A *field study* is an observational study in which researchers observe behavior in a natural setting and seek to record measures of behavior and performance. Unfortunately, field studies violate all types of validity to some extent (Webb, Matthews, Greenley, & Burns, 1993). Typically, the researcher is not able to manipulate independent variables but must deal with the conditions that exist in the field (Xiao & Milgram, 1998). The researcher may be able to administer dependent variables but may have to employ primarily observational measures if participants cannot, or will not, perform measurement tasks, or if performance of measurement tasks risks polluting the data, for example by making the participant self-conscious and altering behaviour in some way. If this is the case, the researcher is dependent on whatever behaviours are exhibited by participants (Xiao & Milgram, 1998; see also Ray & Ravizza, 1980, pp 268-270).

A *case study* is an in-depth form of field study, typically focusing on only one or two participants, which is insufficient for statistical analysis. In this instance, the researcher has little control but may be able to employ more refined measures tailored to the participant.

### 10.1.3 Surveys

Two forms of surveys were used in the studies reviewed: knowledge surveys and retrospective surveys. *Knowledge surveys* are questionnaire or rating instruments (e.g., Horvath et al., 1994a, 1994b; Sternberg & Wagner, 1991) developed to assess individuals' knowledge in some theoretically derived area, such as tacit knowledge . Knowledge surveys are developed through a detailed process in which researchers review documents and interview expert practitioners in the area of concern to identify the relevant knowledge base. With that, researchers develop the survey instrument in a form in which participants can indicate their knowledge. The validity of the instrument can be assessed by administering the survey to an independent sample and determining the extent to which scores predict knowledge levels as assessed by independent measures (e.g., expert ratings, job performance, etc.).

A knowledge survey can be used to assess the amount of domain knowledge possessed by an individual, the organization of the knowledge, or the overlap between individuals' knowledge. Subsequently, possession of the knowledge in question can be examined for correlation with different variables of interest such as background experience, team diversity, selected team behaviours. Thus, it is a useful measurement technique that can be employed in conjunction with other approaches, notably experimentation and field observations.

*Retrospective surveys* are exemplified by the method used by Amason and Sapienza (1997). Having obtained agreement from the CEO's of a set of firms in question, these authors identified members of top management teams in the food processing industry and surveyed them about one particular strategic decision, already identified by their CEO. Their survey used established scales to assess sources of conflict occurring among team members during decision making and the processes used to resolve that conflict. A similar approach was used by Knight et al. (1999) to relate sources of diversity within top management teams with group processes and the level of strategic consensus achieved. Survey techniques may be combined with interview techniques to much the same end For example, Hoopes and Postrel (1999) combined survey and interview techniques within one large firm to identify and examine "glitches" or failures to communicate key information within multi-disciplinary new product teams.

### 10.1.4 Task Analysis

Task analysis is used to identify what the operator of a system is required to do and to describe how the operator interacts with the rest of the system/process (including other operators; i.e., team members) in terms of information required, actions taken, outputs generated, and so on. This technique is also useful for exploring issues pertaining to expertise and differences in performance between experts and novices. Especially relevant to behavioral research are techniques that integrate task analysis with cognitive, behavioral, and sociometric analyses.

Performance prediction techniques are used to predict how well an operator of a system will perform their tasks. Prediction can be made in terms of measures such as speed of completion, perceived workload, error rates, interaction rates, direction of information flow, or other behaviorally relevant measures.

Two specific forms analysis - Cognitive Task Analysis (CTA) and Conceptual Mapping (CM) - are worth describing in more detail because they frequently used in behavioral studies. CTA is a family of methods designed to analyze the thought processes of people while they do a job or task (Randel et al., 1996). The goal of CTA is to identify the knowledge, skills, decisions, and information processing involved in performing the task. CM techniques are a means to analyze and characterize performers' mental representations of their jobs. CM provides a detailed description of the participants' knowledge, including the organization of task-related concepts. This knowledge representation can be used to identify information requirements as well as conceptual relationships that facilitate or impair the use of certain strategies.

### 10.1.5 Simulation

An increasingly important means to examine complex behavior is through simulation. Simulation can take two forms. First, researchers can simulate the complexity of an environment or task domain for the purpose of creating realistic and challenging settings in which to observe human behavior. In this case, simulation is a tool in the service of another research approach. The second form of simulation consists of formal abstract models intended to represent the contents and processes of human cognition in a specified domain. In this case, simulation acts as a theoretical tool with which to assess the accuracy and completeness of theoretical accounts of human cognition.

## 10.2 Specific Methods

To illustrate the general approaches to measurement, we reviewed a number of specific techniques that could be applied to the study of Common Intent and related concepts.

1. **Probe techniques**
   Various forms of probe techniques have been used to examine situation awareness, decision making, and mental models. Two forms of probe technique are potentially relevant to the study of common intent: a "*freeze*" probe and an "*embedded*" probe. Both kinds of probes can be administered at an individual or team level but must be used in conjunction with a scenario or task setting.

   A *freeze probe* is derived from the Situation Awareness Global Assessment Technique (SAGAT) method (Endsley, 1995). Using this approach, a scenario would be momentarily frozen (or an exercise interrupted) and questions posed to participants regarding current knowledge of factors deemed pertinent to performance in the scenario or task. Participants may, or may not, be allowed to interrogate the system or resources with which they are working to answer the questions. This depends on whether one wants to assess current knowledge in isolation from the system, or the speed, accuracy and completeness with which information can be acquired, and/or the type of information sought and the source consulted.

   The advantage of the freeze probe technique is that it directly queries the (almost) current state of knowledge with little chance for memory decay. Virtually any aspect of the knowledge state can be probed. The major disadvantage is that the method may disrupt on-going task related information flows and it may risk inducing artificiality to the task. Once participants know that they will receive such interruptions and probes, they may change their natural behaviours to meet the demands of the test environment. Furthermore, once the scenario is resumed, participants may have to expend time and cognitive resources to regain awareness and resume tasks in hand.

   A variation on this approach is to tape the scenario and then conduct a cognitive walkthrough with the participants afterwards and probe for their recollections of information used at predetermined points in the scenario. The disadvantage of this approach is that memory fades and that responses may be distorted by information gained at other points during the scenario.

An *embedded probe* is an item of information or request for information injected naturalistically into the ongoing scenario. The probe can be disguised as part of the normal message traffic or flow of data thereby creating no interruption to the normal state of activity of participants. Participants' responses to the probe occur as part of their normal operational actions and are captured as data. The embedded probe method allows for a good range of flexibility both in terms of how and when the probe is delivered and the nature of the responses expected. A probe could have any of the following characteristics:

- Information provided in a briefing package.
- Information provided at the beginning of a scenario/task.
- A message from outside the task setting.
- A message from within the task setting (by paper, direct voice, or audio net).
- Information embedded in normal displays.

Although it is not possible at this stage of the analysis to prescribe the circumstances in which each type of probe might be adopted, there is one major constraint that should be noted. In general, the longer and more complex the test scenario, the less control can be exercised by the measurement team over the evolving conditions. Hence, there may need to be artificially halt an evolving scenario at several points during its unfolding and to return to a baseline state. In such a circumstance, the freeze probe methodology might be more suitable than the embedded probe technique.

2. **Common Ground**
Clark and colleagues (Brennan & Clark, 1996; Clark & Brennan, 1991; Isaacs & Clark, 1987; Schober & Clark, 1989) have used a general methodology (originally devised by psychologists Krauss and Glucksberg, see Schober & Clark, 1989) to study common ground and grounding in communication. In this paradigm, one participant, the *director*, views an array of objects and communicates (typically verbally) with a second participant, the *matcher*, to direct the matcher to arrange the same set of objects in the same pattern. The matcher is not provided access to the director's array and the pair must rely on communication to complete the task. Numerous aspects of the paradigm can be altered to study different aspects of communication patterns, content, and subsequent comprehension. These include the familiarity of director and the matcher with each other and the material, the degree to which they hold mental models in common, the effect of the communication medium on the transfer of information, and the nature of the objects in the array. A variation on this theme is to examine the relative comprehension of an *overhearer* who can hear and/or observe the interaction between the matcher and director but not themselves interact.

3. **Methods for measuring mental models**
Kraiger and Wenzel (1997) have reviewed a number of potential methods for measuring shared mental models. These methods assess knowledge, behavior, and attitude components of mental models in terms of commonalties among team members.

   - **Categorization**: Team members are given cards listing common attributes of teams, diagnostic steps, action steps, or situational cues to sort into categories of their own devising. Statistical analysis techniques such as Multidimensional Scaling (MDS) or conceptual mapping are employed to uncover the dimensions underlying each member's sorting and to compare the overlap in organization among members.

- **Probed Protocol Analysis**: This is an interview technique in which members of a team are provided with a series of steps necessary to perform a team task and asked to explain the rationale of each step and the functions of other team members. Answers are scored for correctness and for the degree to which they overlap with answers of other team members.
- **Structural Assessment**: This technique assesses the organization of knowledge in team members' mental models and how members jointly define interrelationships among key concepts. Participants are presented with a set of core concepts pertaining to the team task, resources, roles, etc. Participants then provide similarity or relatedness judgments among every possible pair of concepts. A data representation process, such as MDS or link-weighted networks, is used to generate concept maps for each participant, which are then evaluated to assign an index of sharedness at the team level.
- **Shared Expectations**: The extent to which members of a team share common task and team expectations can be assessed by asking each member to indicate what other team members are likely to be doing at any point in time (typically with respect to a scenario to allow concrete predictions). The accuracy of these expectations is scored by their correspondence to observed or specified behaviors for each team position.

4. **Information Flow Method**
The Information Flow Method (IFM) (see Randel et al., 1996) creates a flow chart that depicts who receives information, who sends it, and what transformations occur at each step. The model is developed by interviewing participants about a scenario. Participants draw diagrams of how information would be communicated in that situation. Each individual in a team task (i.e., an information receiver/transmitter) is represented by a box. Arrows indicate the direction of information transmission. The IFM method works more effectively if the researcher employs a number of representative scenarios. After interviewing participants, the researcher creates a composite diagram containing all the elements mentioned by participants. Again, this is a somewhat subjective procedure. The value of the IFM method is that the model indicates both direct and indirect communication. It is very useful for comparing information needs of individuals against communication procedures to determine how well those information needs are met.

5. **Rating techniques**
Targeted Acceptable Responses to Generated Events or Tasks (TARGETS) is a scenario presentation technique (see Fowlkes et al., 1994) that employs rating techniques to assess team processes and performance. The first step in TARGETS is to identify team skills or the behaviours that could occur in an operational setting (these will form the basis of the rating checklists). The second step is to determine which team behaviours can occur at any given critical point in a scenario. Scenarios are designed to provide measurement opportunities for all team behaviours in operationally relevant routine and critical contexts. Acceptable task responses are defined a priori by task analysis, review of standard operating procedures, and/or SME judgments. Independent raters are given checklists based on this analysis and trained to detect and code relevant team behaviours. During scenarios, raters observe and record how the team performs. The checklist can be revised and refined to allow raters to detect relevant behaviours. This technique has yielded ratings with good validity and reliability (Fowlkes et al., 1994).

6. **Team Performance Assessment**
   The Team Performance Assessment Battery (TPAB) is a generic scenario presentation technique in which teams work on realistic military C2 problems using low-fidelity workstations (Weaver et al., 1995). An advantage of TPAB is that it permits multiple tasks, including monitoring tasks, to be imposed on teams to assess factors related to workload. Thus, TPAB is suitable for assessing resource management aspects of team performance. Specific measures can be rating-based or performance-based (reaction time, accuracy, etc.). This method is performance oriented and would be most useful for determining performance implications of manipulations of common intent.

7. **Group Problem Solving**
   There are several examples of specific problem solving tasks employed by researchers. For example, Murphy, Blyth, and Fiedler (1995) employed the Desert Survival Problem (Lafferty & Pond, 1974, cited in Murphy et al., 1995) to explore leadership and team functioning. Participants form a three or four person group and one is assigned the role of leader In the Desert Survival Problem, participants imagine that they have crash-landed in a desert region in the southwestern United States in mid-August. In the problem, all 15 items of equipment carried by the group have been destroyed. Participants are asked to rank order the equipment items in declining order of survival value and to evaluate possible solutions, including deciding whether to (correctly) remain at the crash site or (incorrectly) hike toward a community 70 miles away. The group's rankings and decision are evaluated with respect to those of survival experts.

   Another is the hidden profile problem (Graetz et al., 1997) which requires participants to pool information unique to each of them to reveal an otherwise hidden solution. Graetz et al. used a problem concerning compliance of different bids for military equipment with a requirements list, but the approach would lend itself to comparison of, for example, courses of action related to stated mission objectives being compared among a team of diverse specialists.

   Rentach et al. (1998) studied two-person teams solving a simulated rescue task to examine factors such as similarity of team mental models, depth of information exchanged, communication patterns, consensus, group cohesion, and meta cognition .

   In some instances (e.g., Wittenbaum et al., 1996), participants were told to anticipate and prepare for a particular type of problem that would be solved in a group context and given information about the people with whom they would be teaming to solve the problem. Before actually completing the task, participants were asked to recall task-related classes of information. Differences in recall patterns were held to reveal anticipatory strategies based on expectations about the coming task and the perceived capabilities and roles of other team members.

   Shattuck (1996) provided walked experienced military participants through a scenario and plan for a military operation and examined their reactions when the operation did not go according to plan. His interest was in the manner and degree to which subordinate commanders used the superior's statement of command intent to adjust the plan and keep it on course.

   Different tasks have different advantages and disadvantages which need to be reviewed carefully in terms of the objectives of the study and the controls required.

8. **Collaborative learning**
   To assess shared mental models, Jeong (1998) developed a paradigm in which pairs of participants

engaged in collaborative learning of the human circulatory system. Participants' initial mental models of the system were assessed through questions designed to tap various knowledge of circulatory system and a drawing task, in which participants produced a diagram of the blood path of the circulatory system. After working together through audio- and video-taped lessons, the pairs were re-tested in the same fashion. Jeong (1998) assessed the degree of overlap before and after learning in terms of the overlap of question answers and blood path drawings. The accuracy of each participant's mental model was assessed by comparing their answers and drawings to information for the training course. Although used with university undergraduate participants and educational material, this technique could be adapted to virtually any domain and to larger group settings.

9. **Team communication**
Entin et al. (1993) developed a team-communication coding instrument to assess the nature and direction of communication flow between two members of a helicopter cockpit crew. In particular, the instrument captured communication rate and type, function, and directionality of communication. The instrument consists of a matrix formed by type of communication (requests for information, action/task, problem solving/planning, transfers of information, action/task, and problem solving/planning) along the vertical dimension and team member position along the horizontal dimension. An observer can then count instances of each type of communication by individual to create a quantitative record. Records obtained from different crews or from different times by the same crew can be compared to identify differences in communication functions. Although developed for helicopter crews, the instrument could be adapted to other team settings and tasks.

   Sperry (1995) and Stasser and Hinkle (1996) used a simulation of a naval combat information centre to study vertical and lateral team communication patterns in relation to team work, mental models about team work and the distribution of diagnostic information among the team, and different aspects of task performance. These studies used observers, self reports, and automated data capture software and calculated measures such as *anticipation ratios* (proportions of information sent to information requested).

## 10.3 Criteria, Measures and Methods

Based on a framework used by Matthews, Webb, & Bryant (1999), we identified measures and methods in the literature reviewed applicable to the C2 domain with respect to three elements. First, a *criterion* identifies a broad dimension of interest and then, to specify and operationalize the criterion, there are specific *measures* and *methods*. In most cases, there are multiple measures and methods applicable to a given criterion that provide differing levels of diagnostic power, or are applicable in different contexts.

Evaluation can first be considered from, the perspective of a "Criterion," which identifies a broad dimension of evaluation interest. Next, to focus and operationalize the criterion, a specific "Measure" and "Method" should be devised or selected. Finally, a "Standard" will have to chosen by which to interpret the data.

In some instances the criterion may remain the same while the measure and method may vary according to the need for precision and the availability of resources. The standard is an external, usually operational, point of reference that will vary according to any number of factors. Such factors might include the need to compete or dovetail with other systems, natural or man-made. For example, to evaluate a criterion of "awareness for new information" for a mock up of a proposed display format, a rating scale might be used by experienced SMEs as they walk through a standard scenario to estimate acceptability (see Matthews et al., 1999). The standard might be that the mean scale response (taken from at least four independent SME reviews) on a five point scale must be at least 3.5 (with 1 being "completely unacceptable" and 5 being "completely acceptable"). Later, using a working prototype for the display, the same criterion might be evaluated by measuring the time taken to respond to incoming information or accuracy of recall for information with the standard expressed, respectively, in seconds or the number and type of errors. Standards cannot be chosen at this stage and necessarily will involve operational insight. Moreover, Standards may change as technological options such as weapon or sensor systems develop and response times or greater areas of surveillance become available.

| CRITERIA | MEASURE | METHOD |
|---|---|---|
| Speed of awareness of new information | Time to show appropriate response to information change | User response time |
| Accuracy of perception of new information | % information misidentified | Track user mistakes and errors |
| Ease of use | % users rating feature(s) as "Acceptable" | Rating on scale by SMEs after performing standard tasks |
| Speed of message preparation | % users able to prepare message(s) within time limit for each workload condition | Time users preparing standard messages under differing workloads |

**Table 10.1: Examples of Criteria, Methods and Measures (From Matthews et al., 1999).**

In the remainder of this section, we suggest criteria, methods, and measures for different aspects of common intent reviewed in earlier sections. These aspects include not only those directly pertaining to measurement of common intent itself but also aspects related to assessment of the effects of common intent and the processes of sharing intent. Specifically, we suggest criteria, methods, and measures with respect to the quality of intent, shared mental models, coordination, group processes, decision making, and communication.

### 10.3.1 Quality of Command Intent

We distinguished earlier between common intent, the complex organization of knowledge, values, practices, and attitudes of individuals, and command intent the more specific organization of knowledge, principles, attitudes, values, goals, and constraints that make up a commander's plan for a specific operation. Command intent is based, in part, on common intent and serves as a link between common intent and the implementation of C2. Thus, it is important to assess command intent in some way to determine how common intent influences C2.

Although the focus of research on C2 is often on the processes of acquiring, sorting, and acting upon information, a key consideration is the quality of the command intent in terms of plans and decisions (Builder et al., 1999). Effective C2 is predicated upon the completeness and appropriateness of command concepts as well as upon processes for sharing intent. To study the quality of command intent, we must develop measures and methods within the context of military planning, in which command teams plan an operation or mission aimed at achieving specific objectives within the larger context of broader objectives specified by higher levels of command. The measures and methods should be applicable to the hierarchical command structure of military organizations. Outcome-based measures such as mission success have been shown to be less appropriate for assessing command issues. Not only is mission success difficult to judge objectively, it is dependent on other factors such as enemy reaction, correctness of intelligence estimates, or relative capabilities. In this instance, the assumption must be made that external factors (such as intelligence about the enemy) are correct The quality of command intent will need to be judged on process related criteria such as the following.

- Is the command intent deemed appropriate for mission success?
- Is the command intent complete; i.e., does it cover all the issues needed for subordinate commanders to understand and act within the commander's intent?
- Is command intent expressed in an appropriate manner for the group(s) in question at the targeted level of command (unambiguous, comprehensible)?
- Does the command intent of commanders at various levels of command dovetail appropriately?
- Does the command intent effectively guide adaptation to unforeseen events?

### 10.3.2 Measures

The quality of command intent is a difficult thing to quantify because military plans are complex, mission specific, and there are few universally agreed upon criteria for defining success. Consequently, opinions as to quality are likely to vary widely and consensus judgements will be difficult to achieve. Appropriate measures of quality of intent might include consensus of expert opinion, completeness of coverage, probability of misinterpretation, and adaptability to unforeseen circumstances.

In general, specific measures tend to be subjective, based on expert ratings or analysis of a command statement of intent or concept of operations. In some cases, more objective measures can be developed based on indicators that subordinates have difficulty understanding or implementing command intent to plan, implement, or as a basis for the disciplined exercise of initiative. These measures, however, are more indirect assessments of the quality of intent because other factors can affect subordinates' understanding, and these will need to be estimated and weighed.

### 10.3.3 Methods

The primary methods for assessing the quality of intent are SME ratings or analysis and post-event review of audio, video, and data logs, again by SMEs competent to assess command intent at the level in question. SME ratings would be made on the basis of pre-defined attributes or specific criteria pertaining to the objectives to be achieved.

Table 10.2 identifies some possible criteria for assessing the quality of intent and associated measures and methods.

| **Function** | **Criterion** | **Measures** | **Method** | **Notes** |
|---|---|---|---|---|
| Quality of Intent | *Completeness* | Number or proportion of command concepts | Expert assessment of pre-defined command concepts | e.g., Builder et al, 1999 |
| | | | Expert identification of key concepts | |
| | | Communication<br>volume, pattern, content | Audio/video log | e g , requests for further information |
| | *Ease of adaptability* | Speed of adaptation | Time from unforeseen occurrence | By subordinate commands |
| | | Appropriateness of adaptation | SME ratings | By subordinate commands |

**Table 10.2 - Measures and Methods for Assessing the Quality of Command Intent**

## 10.4 Shared Mental Models

The concept of shared or team mental models appears to capture a number of key elements of Common Intent. In particular, the concepts indicates that people possess rich knowledge structures, that these structures can be shared among people to various degrees, and that knowledge structures are employed in a wide range of activities, such as communication, decision making, and coordination in teams. Thus, measures of shared mental models can be adapted to assess part of shared intent.

### 10.4.1 Measures

Mental models can be measured from several different perspectives. These include:

- The *content* of the mental model: measures to identify what people know.
- The *organization* of knowledge: measures to uncover and depict conceptual relationships among items of knowledge.
- *Sharing* of the same mental model between people: measures to assess the overlap in content and organization between the mental models of individuals.

All of these forms of measures are valid and necessary to fully explore the role of shared mental models in group and organization functioning. Two aspects of content and structure appear paramount. One aspect relates to the team, whereas the other relates to the mission (goals, method of implementation, etc). For team-related aspects, the common subdivision of team mental models into team, task, and resources issues is taken as a point of departure (Heffner, 1997; Mohammed, 1996; Rouse et al., 1992). For mission-related aspects, the pertinent aspects need to be determined and range from being restricted to command intent (purpose and desired end-state), to the full range of elements proposed by Builder et al. (1999).

### 10.4.2 Methods

The primary methods for assessing the content of mental models are knowledge surveys and interview techniques, both of which probe for knowledge items. These methods can be inaccurate due to confounds of context-dependent memory and the difficulty of articulating procedural knowledge. The organization of mental models can be assessed through conceptual mapping techniques, such as card sorting with MDS or Cluster Analysis (Federico, 1995; Kruskal & Wish, 1978).

Assessing the overlap of mental models among individuals requires both knowledge surveys and conceptual mapping. In addition, statistical analysis techniques are required to compute the degree of similarity among knowledge and the organization of representations.

Table 10.3 identifies criteria for assessing shared mental models and their associated measures and methods

| Function | Criterion | Measures | Method(s) | Notes |
|---|---|---|---|---|
| Shared mental model | Mission model accurate and complete. | Identification of mission issues | Several including accuracy and completeness of recognition or recall of mission issues | Compare overlap among command team members<br>Exclude team issues |
| | Team model accurate and complete | Identification of team roles | Rate descriptions of other roles in team | Compare overlap among command team members<br>Exclude mission issues |
| | | Identification of individual capabilities to fill roles | Rate descriptions of people filling team roles | |
| | | Identification of team tasks | Rate descriptions of procedures of others in team | |
| | | Identification of team resources / environment | Rate descriptions of resources (etc) available to team | |
| | Structure of mental models | Conformity with standard mission structure | Conceptual map based on SME recall | Standard. Builder et al (1999), or army doctrine. |
| | | Conformity with standard team mental model | Conceptual map based on SME recall | Standard: tripartite structure in literature. |
| | Shared content | Proportion of concepts in common | Knowledge survey | |
| | | # of questions/requests for clarification | Communication log | |
| | Shared structure | Similarity of knowledge structures | Knowledge survey and data analysis | |
| | Attitudes/Values overlap | Ratings along pre-defined attitude and value scales | Attitude/value survey and data analysis | |

**Table 10.3 - Measures and Methods for Assessing Mental Models**

## 10.5 Group Processes

Teamwork pertains to the ways in which teams or groups function effectively as a unit There are two aspects to this, coordination of tasks and information, and the group processes and motivational issues which underlie effective coordination. To fully capture how teams work, one must assess the several dimensions of team behavior: cognitive, attitudinal, and psychosocial. Issues of coordination pertain to the degree to which task activities of team members dovetail in terms of criteria such as:

- Timeliness of completing one person's task in relation to that of another.
- Anticipation of the information needs of other team members (including pooling individually held information among diverse specialties to solve a common problem).

- Complementary allocation of individual resources to achieve team goals (e.g. recognition of potential duplication of effort and redeployment of one's own efforts in pursuit of the common goal).
- Team communication resources devoted to coordination issues.

High scores on measures related to such issues can, presumably, be achieved with centralized control and exhaustive rehearsal, provided all goes according to plan (theatrical performances depend on this). Some measures will be affected as much by the design of team roles or tasks as by the behaviour of individual team members (i.e., some tasks may, intrinsically, present difficulties or delay the the team in achieving successful performance). However, in relation to the theory of Common Intent and the doctrine of Mission Command, an important issue is whether goal-oriented coordination can be achieved without highly centralized control and with minimal rehearsal. At issue is also whether goal-oriented coordination canbe maintained or quickly re-established when plans must change at short notice in response to changing circumstances.

Coordination can be a difficult concept to operationalize or measure. It is especially difficult to distinguish coordination from individual contributions to team functioning, and to separate it from communication. The precursors of team coordination are largely covered by measures of team mental models (such as the correctness of expectations about team members, tasks, and roles.) Coordination will be measured in the context of preparation and, then, conduct of a mission . During conduct of the mission, coordination may be considered in tow circumstances; either nothing unforeseen happens or some unexpected event occurs. If something unexpected happens, then either the goal(s) remain valid but the plan must be revised or it must be recognized that the goals are inappropriate at one's own level, and modifying the goals in the framework of higher order goals, and the plan. Issues concerning assessment of coordination include.

- What processes or strategies are team members using to work together as a unit?
- How do a team's coordination processes contribute to successful team performance?
- What factors affect the coordination strategies adopted?
- How do team members learn coordination strategies?

These issues will then need to be related to the theory of Common Intent to resolve various issues, such as how coordination strategies are related to different elements in the intent pyramid. This might be done by, for example, comparing coordination of experts and novices, or examining how the balance and content of explicit and implicit communication of intent affects team coordination for different levels of team diversity or in different circumstances.

The second aspect of teamwork pertains to the group processes and motivational issues that underlie effective coordination. To some extent the problem is circular; trust, commitment, motivation, and shared responsibility are determining factors for individuals to implement group processes and, in turn, these group processes lead to trust and commitment which, in turn, lead to more effective coordination.[24] The literature reviewed distinguishes between, among other things, mechanisms, sources, and consequences of cognitive and affective conflict, different group processes to resolve conflict (mutuality, openness), and different dimensions of trust (commitment to the team goals, confidence in capabilities of others, and predictability of others' behavior).

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[24] This is analogous to the reciprocal relationship between explicit and implicit intent (Section XX).

With respect to the theory of Common Intent, the important issue of interest will be determining whether variables such as trust, values or beliefs, and diversity co-vary with various aspects of common intent or shared mental models. The converse, whether reliance on implicit intent increases (and explicit expression of intent decreases) with trust in others commitment or capabilities, can also be explored.

Group processes rely heavily on attitudes, beliefs, and values that may be shared among group members. Most often, these are measured by self ratings gathered through a survey or questionnaire designed specifically to assess attitudes, beliefs, or values toward a specific target. Sometimes, ratings can be made by observers who have been trained to identify behavioral indicators of attitudes and beliefs.

### 10.5.1 Measures

Coordination processes and strategies can be assessed in several ways. One commonly employed approach is to have experts provide ratings of team processes along pre-defined dimensions, such as appropriateness of communication and degree of helping. Another, more objective means, is to assess the presumed behavioral correlates of pre-defined processes. For example, one process would be to have team members predict what information or other resources are needed by fellow team members and pass it along before they are forced to request it. In this case, coordination would be measured by the ratio of un-requested transfers of information to the number of requested information transfers.

Assessing the effectiveness of coordination requires measures of team performance. These can be based on task-based indicators of success (i.e., outcomes related to the specific task or problem that indicate successful achievement of goals) or general indicators of success, such as expert ratings of effectiveness.

For the most part, measures will seek to relate the presence or absence and degree of intensity of a particular group process (such as openness to ideas or levels of affective conflict), feature (such as team diversity), or attitudes of participants in the group process (such as trust in other team members commitment) to some aspect of team efficiency (e.g., use of resources) or effectiveness.

### 10.5.2 Methods

There are many behavioral indicators of coordination, such as helping other team members, transfer of appropriate information, and so on. Assessing these indicators requires continuous observation of a team at work. Observation can be performed in real time by observers who monitor team performance or by recording the team's activities by video and/or audio log, which can then be analysed to identify indicators of cooperation. Some measures can be obtained through the embedded or freeze probe methods, in which team members periodically provide self ratings or answers to questions that indicate relative coordination. Workload and stress can also be measured in this way or by physiological sensors placed on individuals to provide continuous recordings of heart rate, blood pressure, and other indicators.

Several methods can be used to assess group processes, features, or attitudes. Established rating scales can be used as real time probes during team activities, retrospectively by interviewing participants after scenario based team activities, or for questionnaire surveys to members of established teams. Alternatively, trained observers can make assessments of team behaviours such as communication patterns and content in real time or using video or other records. These techniques can also be used in some combination. For example, review of video data by participants and interviewers together, while participants describe on the attitudes or cognitive processes occurring during critical incidents.

Table 10.4 identifies criteria for assessing teamwork and their associated measures and methods.

| Function | Criterion | Measures | Method(s) | Notes |
|---|---|---|---|---|
| Effective Coordination | Anticipate information needs | Anticipation ratio<br>Transfer of un-requested info. | Communication log | Entin et al. (1996) |
| | | Timeliness of submission in relation to others needs | Analyze communication logs<br>Team member ratings<br>Observer ratings | Scenario based |
| | | Correctness of information provided | Analyze communication logs<br>Team member ratings<br>Observer ratings | Scenario based |
| | | Completeness of information provided | Analyze communication logs<br>Team member ratings<br>Observer ratings | Scenario based |
| | | Economy of information provided<br>*Not too little, not too much for recipient in question i.e. balance explicit / implicit* | Analyze communication logs<br>Team member ratings<br>Observer ratings | -Scenario based<br>-varies with implicit knowledge of recipient |
| | Balance team resources | Duplication of effort | Observer ratings | Scenario based |
| | | Switching of effort | Observer ratings | Scenario based |
| | | Proportion of team member role needs supported | Self rating or observer rating | Scenario based |
| | Minimize communication workload | Workload survey score<br>Time spent on coordinating. | Self / observer ratings<br>Communication log | |
| Morale | Level of morale | Anchored rating scale score | Observer rating | |
| | Job satisfaction | Subjective satisfaction | Self rating<br>Questionnaire | |
| Cohesion | Level of cohesion | Self rating score | Perceived Cohesion Scale | Chin et al. (1999) |
| | Level of group variability | Perceived group variability | Self rating<br>Observer rating | |
| | Collective efficacy | Perceived group/team efficacy | Self rating | |
| Shared vision | Shared/unified attitudes | Overlap of attitudes/beliefs | Interview<br>Observation<br>Semantic network analysis | Davis (1996) |
| Trust | Level of *trust* in team | Participant estimates of trust | Rating scale | Substitute other variable of interest e.g. cognitive / affective conflict |
| | | *Trust* related behaviours | Observed instances of helping | |
| | | Expressions implying *trust* | Analysis of communication | |

**Table 10.4 - Measures and Methods for Assessing Group Processes**

## 10.6 Decision Making

In relation to the theory of Common Intent, the quality of command decisions are, by definition, to be judged in relation to command intent for a particular mission. The quality of command decisions must also be assessed in the context of a particular command team (representing a particular level in the organization). Thus, major criteria include how well a decision fits with higher command intent and how the expression of higher command intent (in terms of content or clarity) influences decision making at lower command levels. In turn, the degree to which the content and clarity of command intent turns upon the balance of what is explicitly expressed and what is left implicit is also an issue.

Note that actual mission outcomes are seen as largely irrelevant here since these depend on other extraneous variables in addition to the quality of decisions. The issue is whether decisions faithfully reflect higher command intent, not whether the mission is a success, whether the premises on which higher intent was based were accurate or not, or whether the interpretation of those premises, accurate or not, by higher command was correct. Although it is true that such issues are probably critical to mission success, they are out of scope here.

Other issues concern what decision making strategies are employed and how these strategies relate to implicit and explicit intent. For example, how do experienced decision makers incorporate command intent into their naturalistic decision making strategies, and what is the relationship of explicit and implicit intent to naturalistic decision making and analytical decision making approaches (see Bryant & Webb, 1999)?

### 10.6.1 Measures

Decision making strategies and quality can be assessed for individuals or teams and the approaches to measurement are essentially the same in both cases. Decision making strategies are best assessed through some form of function analysis that documents the behavioral steps employed to reach a decision. Often, a form of CTA is needed to determine the cognitive requirements of a given strategy. The quality of decision making must be assessed with respect to the decision objectives and problem area. A high quality decision is one that achieves the decision maker's goals and produces a state that is relatively favoured within the problem domain (either an optimal state as defined by the problem domain or one that is significantly better than the starting state). Thus, decision quality can be assessed by problem-defined indicators or subjective ratings by observers. Because most problems involve limits on available resources, a common indicator of success is the cost (in time, effort, or money) require to implement a decision.

### 10.6.2 Methods

Measuring decision quality is important for assessing the effects of shared intent. The quality of decisions must be evaluated relative to a standard, such as an expert plan, the judgment of experts, or objective indicators (e.g., costs). Decision quality may also be self-assessed (e.g., self rating of anticipated problems in implementing a decision) but this approach can be unreliable due to biases or confounding factors that distort people's perceptions of a decision.

Table 10.6 identifies criteria for assessing decision making and effectiveness and their associated measures and methods.

| Function | Criterion | Measures | Method | Notes |
|---|---|---|---|---|
| Decision making | Effectiveness | Compliance with command intent:<br>- goal(s)<br>- desired end-state<br>- explicit or implicit constraints | Expert rating or match with template of<br>Observed behaviour or<br>Report by participant | Original or modified plan<br>Mission specific<br>Relate to intent<br>-Two levels up?<br>-Lateral? |
| | Efficiency | Resources used (e.g.):<br>- Time to reach decision<br>- # requests for clarification<br>- Team members consulted<br>- Perceived effort<br>- Alternatives considered | Analyze communications | Relate to clarity of intent, balance explicit / implicit, team diversity, etc |

Table 10.6 - Measures and Methods for Assessing Decision Making

## 10.7 Communication

Communication is central to the establishment of common intent. Not only is it the process by which explicit intent is shared, but many processes of sharing implicit intent also rely on communication. Further, explicit communication depends on implicit understanding of the vocabulary chosen and levels of efficiency and effectiveness of communication vary with the degree of implicit feedback provided by non-verbal cues. Transmission of values, attitudes, and procedures occurs when people interact and communicate, even though the communication may be explicitly aimed at something other than the sharing of values, attitudes, and procedures.

With respect to the theory of Common Intent, criteria focus on the degree to which intent is communicated effectively and efficiently as well as the appropriateness of the balance between what is explicitly communicated and what is left implicit. Analysis of communication content, type, volume, and direction among team members can provide insight into the degree of shared intent and its accuracy and be related to factors such as diversity in the background of team members, the appropriateness of the balance between explicit and implicit communication, and capabilities of the medium employed.

### 10.7.1 Measures

The effectiveness of communication is generally assessed by the degree of understanding achieved by participants in relation to the efficiency of effort required to achieve that level of understanding. Efficiency can be measured in terms such as transmission time and the number of requests for clarification. Thus, one measurement approach is to assess one party's understanding against the intended understanding of the transmitting party. This technique entails the same kinds of measures of knowledge content and structure as used to assess mental models (although, the representation of meaning will likely not be so complex).

For example, for a given command team, for a given explicit message, based on the theory of Common Intent, one might expect different members of the team to have differing levels of comprehension and request different clarifications, depending on the balance between explicit and implicit intent in the communication and in relation to the background of the individuals. Similarly, the same message, passed using different media, could be expected to achieve different levels of comprehension, indicated by the measures adopted.

### 10.7.2 Methods

The main method for measuring communication variables is the analysis of a video or audio log of communication among team members. Observers require sufficient time to review communication logs to identify critical aspects, such as the volume (amount) of communication, types of utterances (questions, information transfers, etc.), direction, anticipation, and so on. Other measures may include levels of confidence on the part of sender, receiver, or listener that the communication has been comprehended with this level of confidence being related to different components of the mental models of the communicators. Analysis is more effective when the key dimensions of communication are specified beforehand.

Table 10.7 identifies criteria for assessing decision making and effectiveness and their associated measures and methods

| Function | Criterion | Measures | Method(s) | Notes |
|---|---|---|---|---|
| Communication effectiveness | Message understood | Clarification requests<br>- #, type, source<br>Confidence in comprehension<br>Appropriateness of behaviour | Analysis of communication log (s)<br>Rating scale<br>Observation of behaviour | Scenario based<br>Applicable to different media: text/audio etc |
|  | Minimize explicit<br>Maximize use of implicit | Satisfaction with detail provided<br># requests for amplification<br>Errors related to implicit | Rating scale<br>Analysis of communication log(s)<br>Analysis of behaviour | *Amplification* = request to make implicit explicit |
| Communication efficiency | Time in communication | Time to compose, send, clarify<br># of requests for clarification. |  |  |
|  | Common ground | Overlap of vocabulary<br>Overlap of concepts | Observer ratings and/ or analysis of communication logs |  |

**Table 10.7 - Measures and Methods for Assessing Communication**

# 11. Discussion and Proposed Research Program

This literature review was begun with the goal of developing ideas related to the empirical investigation of common intent. As became clear, however, the theory underlying common intent needs further development. The review identified two different concepts of intent that are both relevant to C2. One is the traditional military concept of command intent, which pertains to the planning of operations and the communication of an operational plan or vision to guide the actions of subordinate commanders. This concept bears some resemblance to Pigeau and McCann's notion of explicit intent but, as used in military documents, command intent clearly refers to a specific operation. Thus, command intent is tied to a particular time, place, and operational goal. In contrast, Pigeau and McCann's concept of Common Intent pertains to the shared knowledge, attitudes, values, and beliefs developed by members of any organization through a lifetime of experiences inside and outside the organization of interest, and with respect to all kinds of missions and objectives. Common Intent cannot be thought of as a specific mental model for an operation. Rather, it is a more general cognitive and attitudinal structure that plays a guiding role in the formulation, communication, interpretation and implementation of command intent for any given mission, potentially over many levels of command. Thus one important goal of future research should be to determine how the concepts of command intent and common intent are related and might be synthesized.

Another important result of the literature review was the identification of a number of concepts related to common intent, including command concepts, shared mental models, tacit knowledge, and common ground. These concepts are not entirely distinct from one another or from common intent. They clearly overlap in many respects and it can be argued that they advance similar theoretical positions. The closeness of the concepts, however, does not undermine the theory of Common Intent. Rather, it indicates that researchers from different perspectives and interests have converged on the idea that collaborative work in groups and organizations is best understood in terms of shared ideas, values, and beliefs about mission relevant matters. So too, the theory of Common Intent proposes that C2 is not a collection of procedures and processes or a set of tools for collecting or processing information. Instead, the theory of Common Intent relates C2 to mental representations pertinent to the military work domain that are shared within and between given group(s) across different levels of command, which serve as the problem space within which members of the group plan, direct, adapt, and communicate.

By conceptualizing C2 in terms of mental structures or representations of knowledge, beliefs, and values that guide group interaction, the major questions for future research emerge. First, what is the nature of the structure? What is its content and what is its organization? Second, how is the structure formed? What learning processes are involved and what kinds of experience contribute to it? Then, we can ask how the representation guides action. How is it used to plan operations, to communicate the plan, and, perhaps most importantly, to react to unanticipated events and conditions? The research plan developed in this report addresses these basic questions with respect to the concepts of such mental representation identified in the literature. From the literature, we have drawn the major factors that appear to affect the development and use of shared mental representations. The literature has also provided several methods that can be used to explore the impact of these factors in the broader sense implied by the theory of Common Intent.

Many specific research questions can be derived from the very general concerns of the nature, acquisition, and use of common intent. Which of these questions are the most valuable to answer depends on how common intent is synthesized with command intent The concerns of command intent, which are more specific and context-dependent, can delimit the aspects of common intent with the greatest practical importance. In the end, however, the theory of Common Intent deals with shared cognition, which is inherently generalizable to any human context.

An applied research program represents a compromise among a number of goals. In this case we believe the program should:

- Test and advance the underlying theoretical position.
- Build on related research.
- Serve the context of interest, in this case C2 in the Canadian military.
- Generalize to different command settings: different types of mission, different services, and different levels of command.

Key theoretical positions with respect to the theory of Common Intent that need to be confirmed and enlarged include.

- The pyramid structure of implicit and explicit intent and the relative influence of its components.
- The role of implicit and explicit intent within command and control.
- The processes of sharing intent.

These premises form the foundation for predictions about the influence of common intent and the role of common intent in C2 (see Pigeau & McCann, 2000). Thus, a first step of a research program should be to empirically validate these premises.

In parallel with the need to test and advance the theory of Common Intent, we believe research should focus on the degree to which common intent (i.e. degree of shared beliefs, values, attitudes, and knowledge) within a group affects the generation, communication, interpretation and implementation of command intent (i.e. the purpose, desired end state and approach to be taken for a given mission as envisioned by the commander). A key element of this is for teams to be able to recognize the need for, and to exercise, prompt and coordinated tactical initiative (i.e., a change in plan) in the pursuit of strategic mission goals when faced with unforeseen circumstances that nullify the current plan. The relationship of concepts in the theory to overlapping concepts in the literature also need to be examined

This Section suggests a framework in light of the above, in terms of, first, the features of a research program and a research approach, and then some of the research questions that might be answered within the proposed framework.

## 11.1 Features of a Research Program

We envisage a program with a number of features. These features are listed under the following broad categories:

- Primary thrusts
- Issues of context
- Methodological issues
- Future steps

### 11.1.1 Primary thrusts:

- **Command Intent.** The point of departure for examining the impact of common intent and the relationship between implicit and explicit intent should be the statement of command intent (content and format) and how it is understood and implemented in the context of the mission and the team or group. Furthermore, any single statement of command intent must be placed in the context of a hierarchy of command intent so that the intent of higher commands (two up) and lateral commands, as well as lower commands, are lent to the perception of mission goals by a player at any particular point in the command chain

- **Explicit/Implicit Balance.** The sharing of intent is represented by differing balances between explicit and implicit intent. Thus, a key feature of the research program will be to vary this balance, or to examine the effects of a given balance in terms of different aspects of team diversity. For example, a statement of command intent that leaves much implicit may result in more misunderstanding among a team of novices than experts, or a team experts that has never worked together, or a team that has greater diversity of specialist background. On the other hand, highly explicit statements may be counter-productive in some way, depending on the match between the explicit/implicit balance and levels of mission-relevant implicit knowledge among the group.

  Furthermore, for a given person, determination that something is implicit can most readily be made in relation to some explicit statement, direction, or event made or occurring within a specific context. This is meant in the sense that a given explicit direction might be redundant (the information or intention was already in the person's mind); that the explicit statement leaves something unstated (there are unspoken implications or expectations); or that in the absence of explicit direction, some behaviour occurs. In other words, the question "Are there implications?" cannot be meaningful without an explicit reference point. An individual faced with an explicit statement should be able to reveal (verbally or by their behaviour) what is implicit, areas of uncertainty that need further explication and the roots of the knowledge, values or beliefs about what is implicit. By analyzing the responses of different individuals to a given explicit statement, differences in awareness of implications and their sources can be compared against individual histories. With data about such implications in hand, the structure of those implications may then be examined and compared to the theory.

- **Build on established research.** Several areas of research show significant overlap with the theory of Common Intent, or provide methods appropriate for its study. Foremost among these appear to be the following: the theory of command concepts, work on team mental models, common ground in communication, use of communication measures that imply common mental models (e.g., anticipation ratios), TK survey techniques, and group processes for managing the pros and cons of team diversity from an information pooling and decision making perspective. For example, can common intent for a given mission be restricted to and structured in the same way as team mental models; that is with task, team, and contextual components? Or, to what degree should the format and content of any, explicit, statement of command intent conform to the framework outlined in the theory of command concepts?

### 11.1.2 Issues of context

- **Organization based.** There are two aspects to this. First, the theory of Common Intent contends that as individuals pass through different organizations or institutions, they acquire knowledge and skills and take on related beliefs, attitudes and values. Such organizations may include their family, religious or cultural groups, their school(s), technical training, army units, sports clubs, and so on. Furthermore, this experience is proposed to result in a unique mix for each individual that may be characterized as their personal intent pyramid. Subsequently, when individuals come together to perform some task in some context, their interpretation of the directions they are given and how they interact to perform that task, will be determined by the degree to which these knowledge and belief structures coincide with those of other team members, and with the circumstances they face. To test this, it will be necessary to know and control the organizational history of team or group members so that the consequences for relevant task related behaviours of similarities and differences in organizational history among team may be compared.

  There is a second aspect to being "Organization based". This is that this research is being conducted with the needs of a particular very large and diverse organization in mind: the military. Moreover, completion of assigned missions may require interaction among members of several different organizations: civil, national, technical. Thus, any study must not only systematize the background of individual participants, but relate their background to the team roles they may be asked to adopt for the purposes of the study. This aspect overlaps to some extent with the discussion of the team based and mission based issues below.

  Thirdly, organizations are all structured in some way. Organizations with different purposes tend to be structured along different lines: some more hierarchical than others. Whatever the organizational structure, a common feature is delegation of responsibilities. Thus, subordinate commanders will carry their implicit interpretation of the senior commander's statement of intent and base their own statement of intent to their subordinates on that interpretation. This may happen over several steps down through a chain of command. These lines of delegation may lead down through different specialties that, during an operation, will need to dovetail their activities at the lower levels. This implies that there is potential for misunderstandings or misinterpretations starting at a higher level to persist as they work their way down through the levels of the organization. The result may be that one group interprets the implications of a mission in one way and another group in a different way even though, within each group, they are all of one mind. The negative effect of this seems more likely to be felt in situations of uncertainty where detailed controls are absent or routine procedures fail.

- **Team-based**. Teams are perceived as a group of individuals who must work together to achieve a common goal: coordination, interpretation and implementation of command intent for the portion of a mission delegated to them by superior command. Members of teams may, themselves, have, as part of the resources they bring to the team, control over subordinate teams. C2 is exercised by delegation down through a number of levels with various permutations and combinations of group membership, and with varying levels of diversity in terms of factors such as technical specialty, experience, and cultural background. It is among the members of such teams or groups that the influence of common intent will be apparent. An implication of this perspective is that a "commander" needs to be considered as one member in a team, with certain role responsibilities, but should not be the sole, or even the primary, focus of interest in the research. Thus, "team-based" also implies role-based, with the roles in the team being kept the same but the characteristics of the players being systematically varied, and the degree of common intent achieved and its consequences for team performance being the focus of research interest; i.e., the dependent variable.
- **Mission-based.** The relevance of shared intent is established by its relationship to the mission in question. Missions are envisaged as goal oriented or strategic in focus but implemented through a number of tactical tasks that are more procedural in nature. However, this relationship of mission to task is relative, in that what is perceived as a task at one level, becomes a mission when delegated to another team in the chain of command An important aspect of mission based research will be to establish the relevant knowledge content for the mission, explicit or implicit (see below) on which to base assessment of the degree of common or mission awareness achieved by the group. An appropriate approach for this would be the survey techniques developed to determine TK in different areas. Priorities among types of missions would also need to be established; for example between conventional warfare and OOTW, and within each of these categories. Choosing contrasting mission scenarios would carry the benefit of being able to establish the generality of the findings across widely different settings. For example, some missions will challenge deeply held values more strongly than others.
- **Group diversity.** The program should systematically accommodate varying levels of diversity within groups representing different levels within the command structure (e.g., from infantry section to joint service and even multi-national). Study of the relationship between group or team diversity and effective command is seen as a major aspect of the research program in that such diversity is related to different layers within the intent pyramid. Such diversity may viewed in terms of both individual backgrounds and assigned roles within the group (the two are not mutually exclusive). The program should permit systematic and stepwise progression along a continuum of diversity. This continuum would include:
    - low diversity simple single service, single specialty teams (such as an infantry section).

  - moderately diverse single service, multiple specialty teams (such as the combat team, battle group, or naval vessel).
  - very diverse settings such as joint service or multi-national, or ones involving collaboration with civil organizations (such as the Y2K or Ice storm operation).

Studies performed at the simpler ends of the continuum should have the merit of easier access to suitable subject populations and provide for verifying and validating methods modified from previous studies in other domains. However, these studies will need to be designed in a way that permits generalization of the results to more diverse team settings and such results would need to be submitted to systematic validation.

### 11.1.3 Methodological Issues

- **Balance Retrospective and Prospective research methods.** It is seen as appropriate to combine both retrospective and prospective research methods. That is, interview and survey techniques with SMEs should be used to describe the necessary content, processes, and consequences of sharing intent, for mission planning and preparation. Experimental and controlled field studies should examine the impact of factors such as team diversity on levels of common intent and the consequences for understanding and implementation of command intent.

- **Establish necessary controls.** A notable feature of the research reviewed was that many of the studies used hindsight to identify key control variables, the lack of which undermined the validity or generalizability of their results. Such control conditions were sometimes omitted for reasons of economy in time or effort. It is considered crucial to the success of any future research program that these control conditions be taken into account in the design of the program and the mistakes of previous research studies are not repeated. If this is not done, then the program may prove to be a complete waste, or worse, produce unreliable or invalid results which are not recognized as such. Any program, appropriately controlled or not, will represent a considerable cost. It is better to reduce the scope of the program in order to provide appropriate controls than jeopardize the program as a whole.

  Three aspects are foremost among such controls: the structure of the teams and the diversity of the participants; the nature of the experimental tasks in relation the knowledge and skills of the participants; and team history.

  - The *diversity of participants* in the teams studied can be expected to be directly related to the degree of common intent brought to bear on the task i.e. greater diversity implies a lower probability of common intent within the group. Consequently, such diversity needs to be carefully controlled in light of the goals of the particular study, either held constant and consistent with the target population, or systematically varied and associated with specific hypotheses derived from the theory. Factors contributing to team diversity might include specialized technical training, rank or experience, presence or absence of a common vocabulary, and skill with selected group processes such as conflict resolution.

- The nature of the *experimental tasks* and mission scenarios need to be carefully considered. These should reflect key components of real life tasks in the domain of interest and be goal-oriented rather than procedural in nature. This is not to say that complete fidelity of simulation is required (and may not be achievable for many military missions) but clearly validated parallels should be established. For example, military interviewees (Winslow, 2000) reported that working as relief during the Ice Storm was, in some ways, better preparation for peace keeping missions than conventional military exercises. This implies the need for some form of scenario analysis to establish what are the key dimensions and how these are best simulated. Although it is desirable to use less costly options that are readily repeatable and optimize data capture, these options may risk key aspects of validity. For example, one should not assume that the apparent face validity of the most recently available game simulation of infantry tactics provides the necessary scientific rigour. A related aspect is that the chosen experimental task should be considered in relation to the participant population. Particularly for the study of common intent, a simulated infantry task may not generate the same results from undergraduate students, naval officers, or trained infantry soldiers.
- *Team history* (i.e. experience with other team members performance of their given tasks) is held to affect the acquisition of some aspects of common intent or the mental model of the team and its capabilities. Such acquisition is affected by, for example, the nature and frequency of feedback provided about the way in which the task was performed, the growing effectiveness of the relationship among team members, and trust in the capabilities of individuals to fulfill their assigned roles. It is strongly suggested in the literature that teams should not be brought together just once to perform a given scenario. Rather, teams should be studied longitudinally as they build a common base of experience and the manner of feedback by which they acquire, internalize, and optimize application of the insights derived from that common experience should itself be a subject of study The converse is also true. Existing teams, such as infantry sections (in the same way as management or design teams), with more or less common experience may be selected as the unit of study. Such teams might be contrasted with individuals selected according some other criterion and brought together in an artificially created team for the sole purpose of completing the experimental task.

### 11.1.4 Future Steps

- **Examine other potential areas of research.** A number of areas of the research literature were deemed to be beyond the scope of this review. It became clear, however, that such a separation was both difficult and arbitrary and that there are several areas that either overlap the research in this review or are otherwise intimately connected with issues arising from the theory of Common Intent. Such gaps should be closed where possible with a focussed literature review, the results of which are integrated with the present report and a combined research program. Prime candidates include research into leadership (individual and situational), trust among team members (among teams of three or more rather than pairs), attitudes and beliefs, implicit learning and memory, group dynamics, and decision making styles (naturalistic and analytical).

## 11.2 Proposed Research Approach

To exemplify how these features might be brought together, the next section outlines a prototypical research program as a series of steps, some of which may proceed in parallel, several of which will need to be refined by a pilot process. The examples provided below are based on the Army's organization but equivalent examples may be derived for the Navy, Air Force, or other command. These steps would require the project team to:

- **Establish mission types of interest**. To a large degree this will be decided by Department of National Defence (DND) priorities and not by requirements for research. On the assumption that there will not be sufficient resources to examine every combination of team and type of mission, choices must be made in terms of operational probabilities. Thus the options include conventional phases of war, operations other than war (OOTW), types of terrain (rural or urban, climatic area), and several permutations and combinations. Research interests could be served by establishing the range of choices along key dimensions of interest to the theory of Common Intent (such as team diversity) and selecting appropriate points along those dimensions. For example, first choose a relatively low level of diversity (such as infantry sections and fighting in built-up areas (FIBUA)) in which to pilot methods and measures. Then, examine greater team diversity (such as a multi-arm combat team). Finally, verifying those results by conducting a study simulating the most diverse team context likely to be encountered (such as OOTW as part of a multi-national team).
- **Establish command levels of interest.** This would take the concept of a hierarchy of command intent as the point of departure, but could also reflect some aspects of the choices with respect to type of mission. For example, a statement of command intent is expected to take into account of the command intent two steps up and one step down in the command chain. Within a Canadian Army context, this implies a range from brigade downwards with combat team representing an approximate centre of gravity two levels below the brigade. The combat team is also the first level that combines specialists from several different arms, thereby representing a significant increase in team diversity from the levels below. Thus, from the research as well as the operational point of view, a suitable range of command levels would be represented from the infantry section or platoon to the combat team. The highest permanent organizational unit in the Canadian Army, the brigade, exists two levels above the combat team, with the battle group existing between. Considering the need to use participants with appropriate backgrounds, selecting the combat team also provides for the greatest number of potential participants. Thus, it would seem appropriate to focus the program initially at the level of lower diversity (the infantry section or armoured vehicle), then progress to the more diverse combat team The equivalent logic can be applied to the Navy. This would lead to the suggestion that the Command team in a multi-purpose frigate as the equivalent of the combat team, and the single warfare team (for example sub-surface or surface warfare) as the equivalent, in terms of diversity of technical background, of the armoured vehicle or infantry section. In all cases, the size of the team to be studied could be kept in the range of 4-8 roles depending on membership of the chosen team.

- **Establish a mission context (scenario)**. Having decided on the type of mission and the level of command, then a mission context needs to be established in terms of mission goals, the resources available to the team, and the terrain in which an operation will be conducted. The assumptions about the balance of implicit to explicit expectations and communications with other team members will vary with the context of operations If the consequences of different balances for command and control behaviours are to be studied, there needs to be a controlled but relevant context of operations about which participants can make implicit assumptions. Those assumptions can be elicited and compared with variables of interest.
- **Establish relevant dimensions of team diversity.** These dimensions will vary in part with the depth to which the factors bearing on the content of the intent pyramid are to be probed and partly with the ability of the chosen mission context to reveal measurable differences. For example, deep-rooted ethnic, religious and family experiences are proposed as a deeper and more enduring influence on attitudes, beliefs and values than training in military procedures. However, to probe the relationship between behaviour and those beliefs in a meaningful way is likely difficult to operationalize short of real life operations or using retrospective critical incident interviews with those who have been on such operations and are prepared to discuss the issues. Thus, in the early stages of the program, it is probably more practical to concentrate on the factors that are hypothesized to affect the relatively more malleable elements of the intent pyramid such as training and experience in the military, technical background, and levels of experience with the other team members. Thus, in an army combat team, a comparison of military specialties such as artillery, armour, infantry, and engineers together with rank and length of service are likely dimensions of interest. With these decisions taken, likely sources of study participants with the appropriate background(s) can be considered.
- **Establish study participant sampling frame.** If the purpose is, for example, to compare the effect on C2 (i.e. the comprehension, interpretation and implementation of a command statement of intent) of greater or lesser degrees of shared or common intent among a given team, then it will be necessary to systematically control the degree and content of shared experiences among participants in the study. In part, this will be determined by the level of command being studied, since that will define role related diversity within the team and the level of experience of the role players. (That is, greater diversity of military specialty and longer experience for teams at higher levels of command.) However, the theory of Common Intent highlights the importance of non-military sources of values, beliefs and attitudes. To compare the influence of cultural factors of interest, the non-military backgrounds of participants will need to be controlled as well as their military experience and training. Participant needs could be expressed in format similar to a sampling frame for a social survey, based on the components of the intent pyramid. For example, it might be hypothesized that for groups with more common cultural and military experience, shared intent would increase, the need for explicit communication among group members would decrease, and the effectiveness of C2 would improve.
- **Establish mission relevant knowledge.** In order to establish the degree that team members share values, beliefs, attitudes, and a common mental model about relevant team matters, it will be necessary to establish what those matters are for the type of mission in

question. We recommend using the framework for team mental models already established in the literature; i.e., tasks, team and system characteristics in conjunction with the framework provided by the common intent pyramid i.e. military, personal, cultural. Research on team mental models is usually delimited to more-or-less procedural matters. Thus, this framework would need to be extended to include aspects relevant to the theory of Common Intent such as values, attitudes, and beliefs. Then, using SMEs, CTA and TK survey methods, relevant mission relevant knowledge (etc) could be established for the chosen mission scenario. Later stages of research would establish whether, for a given team or individual, the source was implicit or explicit, and the manner of acquisition if implicit.

For example, a structured sample of military participants might be briefed for a infantry task with which they were familiar (such as an infantry urban patrol during a peace-keeping operation.) The briefing would follow the established military format and style, possibly as a video recording by an appropriate military person. After the briefing, participants would be asked how they interpreted the briefing, what was left implicit or unsaid, how they came to know such implicit information, what additional information they might require, and what other sources of knowledge and experience they would draw upon to prepare themselves and to anticipate the reactions of other members of the team, and the decisions they expected to face as they prepared themselves for and conducted the patrol.

Subsequently, participants might be walked through a patrol scenario, and asked for their reactions to different events, some of which would call into question the plan or established procedures and/or pose an ambiguous situation involving real risk to themselves, another member of the team, or a possibly innocent bystander, calling for initiative and coordinated action. Participants would be asked probe questions to determine the sources and relative influence of their past experience(s) in determining their likely response.

Finally, participants could be asked to recount a critical incident in which they had to make a decision based on their own initiative, and asked to describe how they achieved this.

Their responses would be recorded and subsequently coded by independent observers using pre-determined criteria to assign responses to components of the intent pyramid and team mental models proposed in the literature. This categorization could then be compared according to differences in participant backgrounds

Such a process could result in a common intent Mission Matrix of the format shown below in Table 11.1. While this would not be exhaustive, we believe it to be quite manageable, provided the work is well focussed and delimited to a particular type of mission and setting.

| | **Team type: Role 1 (etc) Total knowledge requirement** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Military** | | | **Personal** | | | **Cultural** | | |
| | Task | Team | System | Task | Team | System | Task | Team | System |
| **Explicit** | | | | | | | | | |
| **Implicit** | | | | | | | | | |

**Table 11.1 - Role based common intent mission matrix for command team members**

- **Establish sources of knowledge.** Having established key issues for the common intent Mission Matrix (i.e., knowledge that would need to be held in common by team members), two further research goals can be pursued. The first concerns likely sources of knowledge. This can be pursued by interview and survey methods using appropriate SMEs. The knowledge sources revealed can then be classified in terms of the theory of Common Intent; for example, implicit or explicit, place in the intent pyramid and the manner of its acquisition (socialization, implicit, explicit, dialogue, internalization, etc ). At the same time, other practical aspects can be examined, such as the degree that current socialization and training supports acquisition of the knowledge, the relative criticality of different components for mission success.
- **Establish an appropriate simulation environment.** There are several potential options for studying common intent, depending on the aspect of interest. These options range from abstract laboratory studies using some form of task simulation, possibly software based; through field exercises of varying degrees of realism, to actual operations. Each of these options may be used for direct observation or real time data capture, or as the basis for retrospective data capture using survey or interview techniques. With participants chosen to represent different degrees or aspects of common intent, simple simulation options with carefully designed independent and dependent variables, measure and methods should be able to establish answers to many questions.

  For example, a simple game-based FIBUA (Fighting In Built Up Areas) software that allows interaction between up to five players might be used. This format could examine the impact of team diversity on team mental models and on the balance between explicit and implicit communication of command intent on team communication and mission performance. For instance, to examine the hypothesis that participants sharing more components of team mental models (i.e. greater common intent) would be able to work on a team mission with a lower ratio of explicit to implicit intent (i.e. less explicit instructions), four participant groups might be compared. Each group would represent a different level of shared implicit intent, such as:

    - trained infantry that are used to working together as a team,
    - trained infantry that do not know each other,
    - civilians who are already members of a team and,
    - civilians who are have not met before.

Faced with a common infantry team task, different formats for explicit statement of command intent might then be compared (e.g. purpose and desired end state vs. purpose, desired end-state, and outline method). Dependent variables might include the amount and type of information requested by team members prior to the start of the mission (classified by component of team mental model: task, team and system), and the pattern and content of communication during the mission, in response to various unexpected events.

By presenting teams with a series of missions with or without feedback after each mission, the manner and degree to which implicit intent builds among the team might also be examined.

Further variations could be the medium of communication available to team members, and/or the amount and type of information communicated beforehand to participants about other team members, the task or the context. The latter would permit examination of anticipatory coordination. Interviews with teams after the scenario could be used to examine critical incidents, cognitive and group processes used make group decisions, resolve conflict, pool knowledge and to identify sources of implicit knowledge.

Subsequently, with the general format and approach verified, higher levels of command with more diverse team memberships can be studied. An equivalent approach could be taken for other military command teams such as naval command teams and compared with the results of army teams to establish the generality of the results across different services.

## 11.3 Express Research Questions

Based on the theory of Common Intent, specific research questions and hypotheses will need to be expressed in terms of the framework outlined above.

The beginning of this section suggested that the broad objectives of a research program should be to validate the theory of Common Intent by expanding on empirical evidence in support of the theory while developing practical implications that can be employed by the CF in the context of likely operational settings. Important aspects for the theory of Common Intent that need to be validated and enlarged include:

- The proposed pyramid structure of implicit and explicit intent.
- The proposed processes by which implicit and common intent is acquired.
- The role of implicit and explicit intent within command and control and the effect on team performance.

An important early stage will be to establish a methodology / paradigm within which common intent may be systematically and effectively described and measured in terms of its theoretical integrity and its practical implications such as the impact on command and control issues.

To convert the general research questions into practice, the following aspects of the each question will need to be addressed using the selected paradigm, taking into account existing research findings and methods.

- Method and participant sampling frame.
- Independent variables.

- Dependent variables.
- Hypotheses.

First we describe a general research paradigm and illustrate two initial studies that address development of suitable methodologies at the same time as examining some fundamental issues

Then, we take the general research goals outlined above and illustrate how these might be broken down into more specific research questions that would be amenable to study. The result of this process is tabulated below. Each research goal is broken down first into research issues, then into broad research questions and, in some instances, to specific research questions.

It should be recognized that there are many potential routes through this maze of questions and not all can be answered. While we have made recommendations, prioritizing among and enlarging upon these questions in terms of the priorities of the CF will be the first question to be resolved. Tabulation of the issues in this manner is intended to assist in that process.

### 11.3.1 Research Paradigm

The general research perspective adopted is the link between the explicit and implicit intent for a given mission context and a given set or sets of participant backgrounds. This framework is appropriate for any organization (i.e. interpretation and subsequent response(s) to any explicit statement will depend to some degree on the implicit intent pyramid of the receivers). In a military context, formal and explicit statements of command intent by group leaders are of the most immediate interest. However, any explicit statement by any member of the group may be viewed in a similar light.

Thus for research in a military context, we view a pivotal point as the explicit Statement of Command Intent at any level of command. Research areas of interest may be summarized in terms of precursors to this statement; the format and content of the statement itself and the group processes involved in its presentation; and the consequences flowing from it.

Precursors to the explicit statement might include:

- Assumptions made about the implicit knowledge possessed by those to whom the explicit statement is to be made (e.g. to determine what can be left unsaid or implicit, established levels of common ground).
- The analysis of the situation leading to the plan on which the specific contents of the statement will be based (e.g. according to the theory of command concepts),
- The actual histories of individuals who will be interpreting the explicit statement and the status of their intent pyramids and tacit knowledge for mission relevant matters.
- The degree to which the team mental models held by individuals in the group of the roles of the other team members, their capabilities in those roles, and the context of operations are realistic, overlap and interlock. Associated degrees of confidence and trust in other team members.
- Mechanisms in place for acquiring and sharing or modifying implicit intent.
- The structure of the organization and the status of group processes for facilitating exchange of information, and resolving conflict during decision making at the command level at which explicit statement is to be made and at subordinate levels.

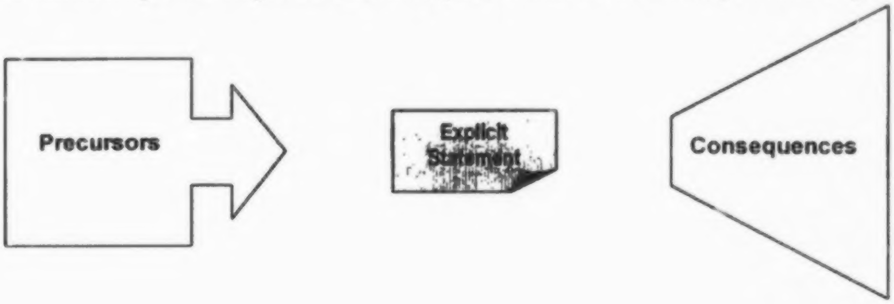
For the explicit statement itself, factors might include:

- The format, length and vocabulary of the statement.
- Content: implicit/explicit balance, topics covered, scope.
- Opportunities provided for feedback to confirm comprehension by individuals in the group, and for group members to confirm their understanding of the implications among other members of the group. The group processes in place to manage matters such as cognitive and affective conflict.

Subsequent to the explicit statement, factors might include:

- Process related performance such as type, content and volume of communication and the degree to which information exchanged anticipates and meets the needs of others in term of appropriateness of content, timeliness of delivery, vocabulary, and matching of implicit/explicit balance of the communication. Other process related factors might include the need for guidance from higher levels of command in terms of degree of coordination achieved and continued compliance with higher levels of command intent in the event of unforeseen circumstances.
- Outcome related performance such as the degree to which explicit and implicit objectives were achieved for the mission. For example, ground controlled or captured, casualties incurred, and resources consumed.

This relationship between precursors, the explicit statement and consequences is depicted below.



- Group composition
- Individual histories
- Individual implicit intent
- Shared implicit intent
- Processes for acquiring implicit / common intent.
- Organizational structure
- Group processes
- Common ground
- Tacit knowledge

- Format
- Length
- Vocabulary
- Implicit/Explicit balance
- Presentation medium
- Content
- Scope
- Group processes used for feedback / clarification

- Information exchange in team
- Anticipating others needs
- Requests for further guidance
- Compliance with higher intent
- Explicit objectives achieved
- Implicit objectives achieved
- Response to the unexpected.

**Figure 11-1: Precursors and Consequences of Explicit Statements of Command Intent**

Below we illustrate two potential research formats that could be used to examine some the specific research questions that are outlined in more detail in the following section. The first format relates more to precursors to an explicit statement of command intent while the second example relates more to the performance consequences of an explicit statement of command intent. Both are intended to be illustrative and have not been developed in detail. Furthermore, both are intended to provide a starting point for a series of linked studies examining different dimensions of the research area such as increasing diversity of team members roles and backgrounds, different levels of command, generalization across different arms, services, or even organizations, or real life validation of simulation studies. Subsequent studies would, of course, depend on the outcome of earlier studies

The first priority is to develop appropriate methods for producing data that may be used to study issues related to common intent. For example confirmation of the reasonable expectation that commanders, in general, will be able to predict implicit responses among team members will help to confirm that the method is appropriate, and provide data to support generally held convictions. However, this is just the starting point: the method must go on to provide more diagnostic data that permits examination of both practical and theoretical interests. For example, the level of success by commanders in predicting implicit intent among team members will depend on the degree to which certain factors are present or absent (familiarity with team members, relevant experiences in common, etc) Not only do these factors and their degree of influence need to be understood, but researchers will wish systematically to relate those factors to the theory of Common Intent.

*Format A:*
*Measuring and analyzing implicit intent in the context of an explicit command statement*

- **Purpose(s).**
  The two main purposes for this study are:
  - to examine a method for assessing the structure and sources of implicit and common intent.
  - to determine if data can be attributed to the three factors proposed for the intent pyramid.

  Other purposes are:
  - to examine expectations by commanders about implicit and common intent.
  - to confirm that, for military teams, individual implicit intent exists.
  - to examine sources of implicit and common intent.

- **Outline.**
  The study would be in two parts.
  Part 1 examines commanders' assumptions about implicit and common intent.
  Part 2 examines subordinates' responses to an explicit statement of intent.

  For this first, exploratory, study, the focus would be on a low level of command with limited diversity in background of team members. Thus the context described is a simple section level infantry mission. The same task would be used in Format B below, to permit comparison. (This example is couched in terms of the infantry, but such a study could be readily set in the context of other arms or services.)

- **Method**

  Both parts would use an interview based cognitive task analysis approach.

  Two structured infantry SME participant samples would be required: a) experienced section commanders and b) section members. Factors used to structure the sample would be related to the theory of Common Intent (for example types of experience, cultural background, length of military service, etc).
  (a) Section leaders.
  (b) Section members.

  Part 1 would ask a group of experienced section commanders to review a explicit section level statement of command intent (purpose, desired end state, outline method) for a simple infantry mission such as an urban patrol during a peacekeeping operation. The explicit statement would be standardized (e.g. presented on video or written) and follow the established military format and style. These section commanders will then be asked to identify what they expect to be implicitly understood by two or more hypothetical types section members and what would need to be made explicit. Hypothetical section members would be described in terms related to the implicit intent pyramid such as their training, background, and degree of common experience.

  In Part 2 infantry section members would review the same explicit statement of command intent. They would then be asked identify what they understand to be implicit and the source of that implicit knowledge (etc), what would need to be made explicit for the team to conduct of the mission, and how common intent for the mission would be achieved. Subsequently, participants would be asked how they would react to an unforeseen situation during the mission, what knowledge, values, attitudes, or beliefs influenced their decision, and the source of that knowledge (etc). The event would be designed to challenge the proposed pyramidal structure of implicit intent, that is, force them to draw on implicit intent based on knowledge, values, attitudes, or beliefs that have not been made explicit for the mission in question and were acquired prior to service in the military. Participants would be asked similar probe questions to determine the sources and relative influence of their past experience(s) in determining their likely response. The purpose of this would be to examine the structure and influence of different levels of their implicit intent pyramids.

  A series of standard probe questions would be designed to elicit data outlined above. Responses would be recorded in real time and coded after the interview. These data would be used to construct a mission intent matrix (see example in table 11.1 above) in terms of implicit and explicit components of mission relevant knowledge, and the reported source of that knowledge (etc). These data would be analyzed to see if they reflected the proposed pyramid structure or simply a set of loosely interacting factors without the weightings proposed. Commanders' predictions would be compared with subordinates' responses. Contrasting histories among subordinate would be compared to determine the relationship between individual histories and implicit intent. Overlap among subordinate histories, their reports of implicit mission intent, and team mental models would be used to examine the effect(s) of common intent.

- **Possible Hypotheses.**
  These might include:
  - CTA methods are appropriate for gathering retrospective intent pyramid data.

- Implicit intent exists in relation to explicit statements of command intent.
- Commanders can predict team members implicit understanding of explicit statements.
- Implicit intent is structured as proposed by the theory of Common Intent.
- Implicit intent is shared among team participants.
- Implicit intent varies with the personal history of individual team members.
- Participants use implicit intent to resolve unforeseen events.
- Participants use deeper levels of implicit intent to resolve deeper challenges.

- **Anticipated lessons learned.**
  The most important outcome would be to establish and refine an appropriate method for studying common intent. In addition, baseline data would be gathered concerning:
  - the structure of implicit intent and the relative influence of its different components.
  - implicit interpretation of explicit intent for a standard military team based task.

- **Limitations**
  The major weakness of this form of research is the subjectivity of the responses and their interpretation. What people say they will do is not necessarily how they will behave. Such data would need to be validated against data gathered using less subjective but comparable sources, such as field exercises, or actual operations. Interpretation and categorization among people coding the responses may also a source of potential variability which will need to be controlled. Practical limitations include the time consuming nature of this approach in terms of the length of interviews, the availability of a suitable range of participants, and the length of time taken to analyze recorded data.

*Format B: Measurement and analysis of C2 performance and implicit intent.*

- **Purposes**
  The two main purposes for this study are to:
  - Examine a method for gathering data on C2 performance and common intent.
  - Examine the impact of shared implicit intent on C2 communication in a simple situation.

- **Outline**
  This study would use a software simulation of a simple infantry task that permits several team members to interact using networked computers during a simple mission in a simulated urban environment. Communication based C2 performance measures would be compared for teams representing differing levels of shared implicit intent. To permit comparison, the same mission / task would be used as in Format A above.

- **Method**
  Different levels of mission relevant shared implicit intent would be compared, for example:
  - trained infantry sections that are used to working together as a team.
  - trained infantry from different units that are not used to working together.
  - non-infantry or civilians who are members of some team or work group.
  - non-infantry or civilians who have not met before.

  Individuals would first be given a standard familiarization with the simulation environment. Team members would then receive a standardized explicit statement of command intent for a simple mission. Team members would then be assessed in terms of selected aspects of mission relevant implicit intent such as team mental models (tasks, team members, and context) and common ground (common vocabulary).

During performance of the task, communication would be recorded and analyzed in terms of measures such as volume of communication, types of communication, requests for explicit information, and anticipation of others behaviour or information needs. Subsequently, communication measures would be compared across the different levels of shared implicit intent.

This format might be extended in several ways. For example, over as series of missions, the rate of change in shared intent and associated performance measures might be examined under different conditions of between mission feedback.

- **Possible Hypotheses**
  Team members who have worked together show:
  - greater overlap of mission relevant implicit intent (common intent).
  - need lower levels of explicit intent (as shown be less requests for information).
  - better anticipation of others needs.
  - better coordination in unexpected situations.
- **Anticipated lessons learned.**
  The main lesson to be learned concerns the suitability of this format for the study of the effects of implicit and common intent on C2 performance. It will also result in baseline data on the relationship between common intent and information exchange within teams.
- **Limitations**
  The major limitation of this approach is that such simulation formats are unlikely to represent a realistic challenge to any but the more procedural aspects of common intent resulting from military training. Communication content during such a simulation might reflect beliefs about group processes and implicit understanding of simple military procedures. However, it is not likely to reflect the relationship of fundamental values and beliefs and to behaviour under the real stresses likely to be present in such situations. This study should be regarded as one that should be repeated at increasing levels of realism, first under exercise conditions, and then again, probably retrospectively, under operational conditions.

### 11.3.2 Research Goals and Questions

This section takes the general research areas outlined above and illustrates how these might be broken down into more specific research questions that would be amenable to study.

- The structure and content of individual implicit and explicit intent.
- The processes by which implicit and common intent is acquired.
- The role of implicit and explicit intent in C2 and the effect on team performance.

The result of this process is tabulated below. Each research goal is broken down first into research issues, then into broad research questions and, in some instances, to specific research questions.

<table>
<tr><td colspan="2"><b>Research Goal:</b> Determine the content and structure of individual intent pyramids.</td></tr>
<tr><th>Research Issue</th><th>Example Research Questions</th></tr>
<tr><td>How can implicit intent be measured?<br>Do individuals possess implicit intent?</td><td>Can implicit intent be determined using:<br>- self report methods such as CTA, or TK questionnaires?<br>- behavioural or communication measures e.g. anticipatory communication?</td></tr>
<tr><td>Is the pyramid structure of implicit intent valid?</td><td>Can reports of implicit intent made in response to explicit statements be organized in terms of personal, organizational and cultural elements?<br>Define military contexts in which the three intent levels have different effects<br>How are components of implicit intent related to shared team mental models?</td></tr>
<tr><td>Does the effect of implicit intent differ for different components or levels of an intent pyramid?</td><td>Do individuals reveal greater awareness of implications related to different levels in intent pyramid?<br>Do individuals claim or reveal greater influence according the roots of given implications in the intent pyramid?</td></tr>
<tr><td>Does implicit intent vary among individuals according to their personal, organizational or cultural history?</td><td>Do individuals with different histories differ in the implications they draw from given explicit statements?<br>Does the behaviour of individuals with different histories differ systematically after given explicit statements?</td></tr>
<tr><td>Does implicit intent overlap among individuals?</td><td>Do individuals with similar histories recognize similar implications with respect to a given explicit statement of intent?<br>Can implicit intent for a given mission be determined and common intent within a given group established?</td></tr>
<tr><td>Does the structure and content of implicit intent overlap with related concepts in the literature?/</td><td>For an explicit statement of command intent to be satisfactory, should its content conform to the theory of command concepts?</td></tr>
<tr><td>Do components of implicit intent vary in their value to different organizations?</td><td>Can unique organizational needs be related to different components of implicit intent? Do these needs differ with context or type of mission?</td></tr>
</table>

**Table 11-2: Determine the content and structure of individual intent pyramids.**

| **Research Goal:** Determine how implicit and common intent is acquired by members of a team. | |
|---|---|
| **Research Issue** | **Example Research Questions** |
| What are the sources of implicit intent? | What sources do individuals' cite for their understanding of the implications of a given explicit statement?<br>What sources do individuals' cite for implicit behavioural responses (i.e. made in the absence of explicit direction)? |
| What are the mechanisms for acquiring implicit intent? | Do team members with frequent verbal interaction show more common intent?<br>Do team members with similar (but separate) histories have more common intent?<br>Do team members with shared relevant experiences show more common intent?<br>How do organizations modify members beliefs and values?<br>How do team members internalize explicit statements of command intent?<br>How does motivation of team members affect sharing of implicit intent?<br>How do team members know what intent is already shared between them? |
| What factors affect acquisition of common implicit intent? | Does membership of multiple organizations affect acceptance of common intent?<br>Does richness of personal interaction (e.g. frequency / intimacy of contact) affect acquisition of common intent? (Madhavan and Grover 1996)<br>How does affective & cognitive conflict affect acquisition & sharing of implicit intent?<br>Does trust in other team member's commitment to team goals affect acquisition of common intent?<br>How is affective and cognitive conflict affected by within group diversity?<br>How does the format of explicit statements affect acquisition of implicit intent? (i.e. internalization.)<br>Do communication constraints and medium affect cost and effectiveness of acquiring common intent? (Brennan and Clarke, 1996) |
| How does organizational support affect acquiring or modifying implicit intent? | How does the organization support appropriate group processes?<br>Does organizational support for open & lateral communication affect common intent? |
| What training strategies are most effective for acquiring appropriate implicit intent and promoting mission appropriate common intent? | Do training simulators, field exercises and operational experience differ in their impact on acquisition of implicit or common intent?<br>Do cross, coordination and cooperative training affect acquisition of common intent in different ways?<br>How does diversity among team members affect the effectiveness of training strategies for acquiring common intent? |
| How can mission / task relevant aspects of common intent be identified? | Does the theory of command concepts reflect necessary and sufficient coverage of information (etc) needed for effective common intent for a given mission |
| What is the most effective way of confirming appropriate common intent exists within a mission team? | Does verbal feedback by team members about shared implicit intent accurately predict subsequent behaviour?<br>Can team members confirm their common understanding of explicit statements of command intent in same way as a conceptual pact (Brennan and Clarke 1996 ) How is this affected by the medium of communication (face to face, text, radio, etc)?<br>What methods exist (e.g. rehearsal, backbriefing, wargaming) to confirm common intent? |
| How does other evidence relate to acquiring implicit intent? | How does theory common ground relate to the acquisition of common intent?<br>Does tacit coordination affect sharing of implicit intent?<br>How do team mental models affect acquisition of common intent? |
| How does team diversity affect acquisition of common intent? | What is the effect on acquisition / sharing implicit intent of factors of team diversity such as: age, education, rank, technical specialty, experience, culture, race, role?<br>Do A and T skills (Madhavan and Grover 1996) facilitate common understanding of command intent? |

**Table 11-3: Determine how Implicit and common intent is acquired.**

| **Research Goal.** Determine the role of common intent in C2 and its effect on team performance. | |
|---|---|
| **Research Issue** | **Example Research Questions** |
| How are explicit statements of intent formulated? | Do team members actively balance format, content and focus of explicit information with their mental models (implicit expectations) of other team members knowledge, values, and beliefs?<br>How do team members determine what knowledge, beliefs, attitudes (etc) need to be shared to implement the mission. |
| How are explicit statements of intent related to common intent? | Do teams with less common intent exchange more explicit information about mission relevant matters before and during a mission?<br>How do team members determine existing and desired levels of mission related common intent within a team? |
| How is an explicit statement of command intent communicated most effectively and efficiently? | What is the impact of providing information that is already implicit for the receiver?<br>How do team members confirm implicit understanding of command intent (e.g. backbriefing, rehearsal, wargaming)?<br>What is the most appropriate format and content for explicit statements of command intent?<br>Do opportunities for lateral communication result in less reliance on implicit understanding of command intent to coordinate mission activities?<br>Can command communications be limited to Builder et al.'s (1999) questions about the ongoing acceptability of command vision? |
| How is decision making affected by common intent? | Do teams with common team mental models detect emerging problems more effectively?<br>With greater common intent, are team members' decisions more likely to comply with command intent? |
| How is communication during a mission affected by common intent? | Do teams with greater common intent communicate in different ways?<br>Do teams with greater diversity among members communicate less effectively or efficiently?<br>Do teams with common team mental models share implicit information more effectively?<br>Do teams with greater common intent better anticipate information needs among team members? |
| Is team coordination affected by common intent? | Does shared implicit understanding of other team members tasks / roles improve team coordination?<br>Do teams with greater diversity coordinate their actions less effectively?<br>Do long established teams exhibit greater "group think" and less ability to adapt to unexpected situations?<br>Are teams with greater common intent more able to coordinate their responses to unexpected situations? |

**Table 11-4: Determine the role of common intent in C2 and its effect on team performance**

## 11.4 Summary

In summary, the following steps have been proposed for a research program. These steps may overlap or occur in parallel.

1. **Establish mission types of interest to the CF.**
   We suggest FIBUA types of tasks in a peacemaking or peacekeeping context for theoretical and methodological reasons as well as apparent operational relevance, but this choice is as much a military as a technical matter.
2. **Establish command level of interest.**
   Level of command interacts with level of team diversity, an important theoretical issue. We suggest starting with an infantry section (i.e. less diverse in terms of intent pyramid) to develop methods and validate certain aspects of the theory, then progress to higher, more diverse command teams such as the army combat team or battle group level, to further confirm and expand theory, method and practice.
3. **Establish level and aspects of team diversity to be studied.**
   This is a key decision and requires a balance between practicality and theoretical importance. Greater diversity implies less shared intent for any given group. The nature of the diversity within the groups studied should reflect the theoretical framework under consideration but remain practical.
4. **Establish a mission scenario.**
   The mission scenario adds contextual aspects to the chosen mission type and command level. Thought should be given to integration and continuity of initial studies at lower command levels with later studies at higher, more diverse command levels.
5. **Establish a participant sampling frame.**
   This would be based on the framework of the intent pyramid, in the context set by the results of earlier steps and would determine the cross section of intent related factors (military, personal, cultural) to be represented among participants in the study. It should systematically reflect the aspects of diversity assumed to result from the military, personal and cultural background , the effects of which on C2 process or outcome are to be compared in the study.
6. **Determine mission relevant knowledge and structure**
   Use CTA and TK methods and an appropriate categorization scheme for a given command level within a given mission scenario with a structured sample of military SMEs to establish what implicit knowledge (etc) might be required for the mission / team in question, how that implicit knowledge (etc) is structured, and whether that structure fits the proposed structure of the intent pyramid. At this point, the relationship between aspects of the theory of Command Intent to related concepts in the literature can begin to be explored: for example command concepts, team mental models, common ground, and tacit knowledge.
7. **Establish sources of mission relevant knowledge (etc) and methods of acquisition.**
   Using the same structured sample of military SMEs as in the step above, establish where and how the knowledge (etc) might be acquired, and whether the methods of acquisition match the proposals made by the theory of Common Intent.

8. **Establish the appropriate simulation environment for the study.**
   Choices run on a continuum from simple classroom exercises through software simulation options and field exercises to studies conducted before, during or shortly after actual operations. All of these options represent a feasible context for study, though with differing levels of cost and predictive validity i.e. confidence in the ability to generalize from the results to real life. Methods and some broad theoretical issues should first be addressed using a more economical approach, leaving more costly studies until later in the program where diagnostic needs are better understood

9. **Express specific research questions.**
   This should be done in terms of the methods outlined here, with explicitly stated independent and dependent variables, and hypotheses.

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# 13. Glossary

| | |
|---|---|
| **Affective conflict** | The emotional conflict that arises from personal disputes or incompatibilities. Affective conflict is detrimental to group functioning because it produces hostility, distrust, and other negative emotions among team members, which reduces the exchange of information and mutual commitment |
| **Anticipation ratio** | A measure of the extent to which each team members anticipated each other's needs. It is calculated as the proportion of information sent to information requested or the number of information transfers divided by the number of information requests. |
| **Auftragstaktik** | A philosophy of collective creativity in the face of the unforeseeable opportunities provided by battle, which requires (rather than simply permits) individual commanders at all levels to take the initiative and act in the collective interest to complete the mission as circumstances change (also called mission-oriented command). |
| **Battle Captain** | An individual upon whom a commander relies for information This position, at the level of large units, would be the Chief of Staff or G3 (executive or operations officers at lower levels). One aspect of this role was to know and be able to speak for their commander in matters of intent during preparation and implementation of the mission Another aspect of this role was to provide the commander with a clear picture of the battle in relation to the concept of operations and the continuing validity of the commander's intent in the face of emerging circumstances. |
| **Cognitive conflict** | The task-oriented conflict that arises from differences in perspective or judgment. Cognitive conflict is beneficial to group functioning because it involves debate and exchange of information and ideas among team members. |
| **Command** | The authoritative andresponsible expression of creative human will for the attainment of a mission. |
| **Command and Control** | The establishment of common intent to achieve coordinated action. |
| **Command Concept** | A vision of a prospective military operation that informs the making of command decisions during that operation. An ideal command concept is a "hypothetical statement of the commander's intent that should have been, under the doctrine, training, and common knowledge of the time, clearly sufficient for subordinate commanders to successfully execute the responsibilities they were actually called on to fulfill during battle, without exchanging additional information with their superior commander." (Builder et al., 1999) |
| **Command intent** | The broad concept of the purpose, general methods, and constraints pertaining to a particular operation, which is distinguished from more specific products of the planning process, such as a commander's statement of intent |
| **Commander's Intent** | A commander's overall concept of how an operation is to be conducted and how it will unfold. (See Vision) |
| **Commander's statement of intent** | A document that expresses some aspects of the command intent. |
| **Common ground** | The mutual knowledge, beliefs, and assumptions held by people, which defines concepts and ideas that can be referred to by people in conversation |
| **Common intent** | The sum of shared explicit intent plus operationally relevant shared implicit intent. Common intent is the complex organization of knowledge, values, practices, and attitudes that individuals can use to formulate and communicate goals and plans It serves as a referent for members of the organization (See Shared intent) |

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| **Concept of Operations** | An output of the operational planning process which is distributed to commanders. The concept of operations provides background and a description of the overall plan for an operation, as well as specific directives. |
| **Control** | The application of structure and process for the purpose of bounding the mission's problem space |
| **Cooperative Learning** | A training technique that uses an implicit approach in which trainees are forced to be mutually interdependent to achieve their learning goals. This technique promotes the building of team mental models. |
| **Coordination Training** | A training technique in which members of a team are taught about the specific roles of other team members within the context of the tasks the team will perform. This technique explicitly provides team members with mutual knowledge about team roles and helps team members learn about the information needs, preferred communication patterns, and specific competencies of their teammates |
| **Cross Training** | A training technique in which each team member receives practical, hands-on training in the other job functions within the team This experience forms the basis of a common mental model of the team that all members shared. Cross training is used to develop common shared expectations (inter-positional knowledge) regarding specific team member functioning |
| **Dialogue** | A means of sharing explicit intent through reciprocal communication of specific mission-related information Dialogue occurs during activities such as rehearsals, planning meetings, mission-related training, briefings, questions, and answers. |
| **Embedded knowledge** | The knowledge that results from the combination of individual team members' stores of tacit knowledge; i e., a component of shared knowledge. Much of this embedded knowledge remains latent until someone attempts to combine what team members know. |
| **Embodied knowledge** | Embedded knowledge that has been incorporated into a new product |
| **Experiential learning** | A category of training techniques that train individuals through performance of on-the-job tasks or in very realistic scenarios. |
| **Explicit intent** | Publicly communicated directions such as written or verbal orders that convey a plan |
| **Externalization** | A means of sharing one's implicit intent through creative or expressive acts, such as the use of metaphor, anecdotes, or demonstration of a problem solving approach. Such acts derive from one's rich implicit understanding and even intuition. Once expressed, one person can consider what had previously been concealed or implicit within another's intent pyramid |
| **Implicit intent** | Internalized collective and individual knowledge and expectations that may never be directly expressed but guide actions, consciously or otherwise. Implicit intent derives from the extensive knowledge bases people acquire through experience, such as beliefs, values, habits, expectations, and personal styles, in or out of the military |
| **Intent Hierarchy** | In Pigeau and McCann's (2000) original formulation, a description of the composition of explicit and implicit intent within an individual. Layers within the hierarchy represent contributions from explicit knowledge and personal, military, and cultural influences. (See Intent pyramid) |
| **Intent pyramid** | Suggested new terminology for the intent hierarchy A description of the composition of explicit and implicit intent within an individual. Layers within the hierarchy represent contributions from explicit knowledge and personal, military, and cultural influences. (See Intent hierarchy) |
| **Internalization** | The process whereby an individual integrates (actively or unconsciously) explicit information from others into the implicit levels of his or her own intent pyramid |
| **Knowledge survey** | Questionnaire or rating instruments developed to assess individuals' knowledge in some theoretically derived area, such as tacit knowledge. |

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|---|---|
| **Mental model** | A complex and rich mental representation of knowledge that is organized in terms of the external environment or system that it models A mental model contains elements that correspond to those elements making up the external system and the model elements are inter-related in the same fashion as the external elements |
| **Mission awareness** | Awareness of information pertaining to the objectives, methods, and resources of an operation in terms of command intent |
| **Mission Command** | A style of command core to the Manoeuvrist approach adopted by the Canadian Forces in which all activities must centre on and support the commander's expression of the design of the battle through the commander's intent. |
| **Psychological contract** | An implicit, mutual understanding of mutual obligations between group members and between levels within an organization The contract enforces an interdependency in which members tacitly accept each other's expectations |
| **Shared intent** | The sum of shared explicit intent plus operationally relevant shared implicit intent (See Common intent). |
| **Situation awareness** | A person's state of knowledge or mental representation of the situation, based on perception, comprehension, and extrapolation of events. |
| **Socialization** | A relatively slow process of sharing one's implicit intent whereby one person observes another and draws conclusions about the beliefs, goals, and capabilities of others Socialization may be based on non-verbal social interaction or occur during dialogue as |
| **Tacit coordination** | The synchronization of team members' actions based on unspoken assumptions about what others in the group are likely to do |
| **Tacit knowledge** | A component of practical intelligence or informal knowledge, acquired through observation and experience, about how to solve practical problems Tacit knowledge is procedural, goal related, and acquired with little organizational support. Tacit knowledge applies to three kinds of practical knowledge: managing oneself, managing others, and managing tasks |
| **Unity of Effort** | The coordination and synchronization of action that requires a common focus for potentially divergent activities of subordinate commanders. |
| **Vision** | A commander's overall concept of how an operation is to be conducted and how it will unfold. (See commander's intent) |

# ANNEX A:
# Secondary References

# Annex A

We identified 116 secondary references by identifying potentially relevant articles cited in articles obtained for review. The secondary references comprise journal articles and technical reports from the behavioral sciences, military research, and business/management domains.

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